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THE ELECTRICIAN:

A WEEKLY JOURNAL OF

THEORETICAL AND APPLIED ELECTRICITY AND CHEMICAL PHYSICS.

No. 1.—Vol. IX. SATURDAY, MAY 20, 1882. Price 4d.

SLIP

Brazilian Submarine Telegraph Company.—The traffic receipts of this company for the week ending April 21st amounted to £2,895

Electric Light in Mexico.—It is stated that the Mexican Chamber of Deputies has been lighted by means of electricity for some weeks past.

Electric Light in Vienna.—The Grand Café of the Residence, situated at the corner of the Franzensring and the Schottengasse in Vienna, is now lighted by electricity.

Electric Light for Kensington.—The Kensington Vestry have desired their Works Committee to consider whether it would be expedient to introduce the electric light into the parish.

Electric Light for Theatres.—It is proposed to use the electric light in the Philharmonic Theatre, Islington, which is to be reconstructed from the designs of Mr. Frank Matcham, architect.

South African Telegraphs.—The revenue receipts of the Cape Colony from telegraphs during March last amounted to £5,686, against £5,402 in the same month of 1881, being an increase of £284.

Charing-cross Electric Railway.—The Charing-cross and Waterloo Electric Railway Bill was considered on Friday week in the House of Commons, and read a third time on Tuesday, the 16th inst.

London-Platino Brazilian Telegraph Company.—The revenue of this company for the month of January, 1882, is estimated at £2,281 (Western Brazilian portion £1,517, land lines £764), as against £1,981 for the corresponding period of 1881.

Western and Brazilian Telegraph Company.—The traffic receipts of this company for the week ending April 21 were £1,767, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

Electric Light for Lewisham.—The surveyor to the District Board of Works for Lewisham having reported that the cost of the electric light would be greater than gas, the board have resolved to defer the question of its introduction into their parish for a time.

The Telephone Case.—This case is not yet concluded. The week has been spent chiefly in hearing counsel for the defence sum up the evidence on defendant's side, and the reply of the plaintiff's counsel. It is probable that judgment will not be given until next week.

New Telephone Company.—The National Secret Telephone Company has been incorporated at Albany, N.Y. Capital stock, 5,000,000 dols. The general route to be followed is stated to be from the city of New York to the city of Albany, and from there to the city of Buffalo.

The Sellon and Faure Battery.—The Faure Electric Accumulator Company commenced an action on the 10th inst. against the Electrical Power Storage Company, holding the patents of Messrs. Sellon, Volckmar, and Swan, in the High Court of Justice, for infringing the Faure Company's patent.

Electric Light in Italy.—The results from the use of Siemens's arc lamps in the railway station at Milan have been so good that the Minister of Public Works has decided to extend this system of lighting first to the other stations of the Upper Italian Railway, and afterwards to those of the central and southern lines.

Electric Light in New Orleans, America. — An American contemporary says that New Orleans has got its five miles of river front illuminated by 104 electric lights, and hopes to stop the pilfering of goods piled there, as well as to facilitate work, by this means. The city has in all over 300 lights of the kind in use.

Crystal Palace Exhibition.—As at present arranged, the Electrical Exhibition at the Crystal Palace will close on the 3rd of June. Already several exhibitors have begun the work of removing their goods. The Right Hon. the Speaker and a number of Members of both Houses of Parliament will visit the Exhibition on the 27th inst.

Electric Light in Brighton.—The Committee appointed by the Brighton Town Council to obtain prices for illuminating the front of the town, and the central valley as far north as the parish church, with electric light, for three years, have resolved not to proceed further with the negotiations until the Government Electric Light Bill has been finally settled by Parliament.

Society of Telegraph Engineers and of Electricians.—The next meeting of this society will be held at 25, Great George-street, S.W., on Thursday, the 25th May, when the following paper will be read by Lieutenant A. H. Bagnold, R.E., "The Organisation and Operation of the Field Telegraph Corps in the Transvaal, 1881, also some general remarks on Field Telegraphs."

Electric Light Bill.—The Select Committee on this Bill have been engaged during the week in taking the evidence of gas companies and corporations who supply gas, and corporations who do not. The proceedings consisted chiefly in the cross-examination of Mr. Farrer, secretary to the Board of Trade, by counsel representing the above bodies.

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We shall refer to the proceedings of the Committee at greater length hereafter.

THE JOEL AND PILSEN LAMPS.—The prospectus has been issued of a company formed to work these lamps, under the title of "The 'Pilsen,' 'Joel,' and General Electric Light Company (Limited)." It has also acquired the patents for the "Gatehouse" incandescent light. The capital is £200,000, in 40,000 shares of £5 each, of which 12,000 shares are to be allotted as fully paid to the vendors, and the remaining 28,000 are offered to the public.

TELEPHONES WANTED.—The Guardians of the Salford Union, near Manchester, are inviting tenders for the erection and maintenance of telephonic communication between the several wards of the new hospital at Hope. Specification, &c., may be obtained of Mr. Booth, architect, of 88, King-street, Manchester. Tenders are to be sent to Mr: T. H. Bagshaw, Union Clerk, Union Offices, Eccles New-road, Salford, by the 25th inst., and they will be opened at the guardians' meeting on the 26th inst.

THE NEW ATLANTIC CABLE COMPANY.—Notices have at last been issued signifying that the American Telegraph and Cable Company's line to America is now open for public traffic, and that messages will be accepted at the company's stations, viz., 21, Royal Exchange, London, E.C., and A 5, Exchange-buildings, Liverpool. It will be seen from another note that the various cable companies have, as we hinted would be the case some time since, agreed to form a joint purse, and revert to the old rates.

ELECTRIC FIRE ALARMS.—In the annual report of Captain Shaw, chief of the Metropolitan Fire Brigade, it is pointed out that by reason of the system of electric fire alarms and the excellent telegraphic intercommunication between stations, &c., the various fire engines and men of the brigade can be concentrated on any given spot in a very much shorter time than was formerly the case. Captain Shaw reports that the electric fire alarm system has been found to work well, and it is to be greatly extended.

TELEGRAPHIC COMMUNICATION WITH GREENOCK.—As evidence of defective telegraphic accommodation at Greenock a local paper states that telegrams were despatched from Dublin, on the occasion of the Phœnix Park murders, to Greenock, asking the authorities there to keep a sharp look-out for suspicious characters; but as the telegraphic department of the Post Office in Greenock is closed from 10 p.m. on Saturdays till 8 a.m. on Sundays—and then only open for two hours—the Irish steamers had arrived hours before the office opened to receive the message.

ELECTRIC LIGHT IN THE OPERA, PARIS.—*La Lumière Electrique* says that it is a question whether the *foyer* of the Opera shall not be definitely lighted with the *Lampe Soleil.* Our contemporary quotes from a letter from M. Garnier, the architect of the Opera House, in which he says that he finds the lamp "absolutely perfect as regards steadiness and colour," and considers it as "the best light which can be employed for lighting works of art and picture galleries." According to this gentleman, the sole fault of the lamp is that is rather costly, but this consideration will not prevent its use in the Opera. We gave an illustration of the light as used in the *foyer* in our last issue.

ATLANTIC CABLE TARIFFS.—On the 13th inst. it was officially announced that a joint purse agreement had that day been executed between the Direct United States Cable Company (Limited), the Anglo-American Telegraph Company (Limited), La Compagnie Française du Télégraphe de Paris à New York, and the American Telegraph and Cable Company. Concurrently with this notice came the announcement that the rates to America and Canada are, on and after the 22nd May, to be again raised to two shillings per word. The Anglo-American Company notify a special rate of one shilling per word for Press messages, except for those forwarded between 6 a.m. and 12 noon, the rate for which will be sixpence per word.

ELECTRICALLY PROPELLED BOATS.—One of the features of the International Exhibition to be held in Turin, in 1884, will be a number of boats propelled by electrical energy. Signor Ivaldi, an engineer, Dr. Gasca, and Signors A. Marchi and Nigra, have asked permission from the Municipal Council of Turin to grant them a concession for the exclusive right to establish on the Po, between the windmills called Rocca and the new bridge, a service of boats propelled by electrical energy, supplied by means of special accumulators. They also request the gratuitous use during the exhibition of the hydraulic power of the river in the locality of the Rocca mills, where they will erect the motors for charging the accumulators.

THE FUTURE OF ELECTRIC LIGHTING.—On Wednesday, at the Royal United Service Institution, Mr. Spottiswoode, P.R.S., in the chair, Mr. St. George Lane-Fox read a paper on the above subject. Mr. Fox spoke of the great future before electricity, and dilated on the rapid strides that had been made of late years in its application to various uses. He described the incandescent lamp, which he thought would altogether supersede the arc lamp in a short period. With regard to the danger to human life from contact with wires carrying currents for lighting purposes, that he thought would be overcome by using low tension currents, which were harmless. And as regards fire risks, they could only arise from gross carelessness.

FIRE RISKS AND ELECTRIC LIGHTING.—The Society of Telegraph Engineers and of Electricians have appointed a committee to consider and report upon the rules which they would recommend for adoption for the prevention of fire risks arising from the use of the electric light. This committee is composed of the following gentlemen, viz:—Professor W. G. Adams, F.R.S.; Sir Charles T. Bright, Messrs. R. Crampton, R. E. Crompton, W. Crookes, F.R.S.; W. De la Rue, F.R.S; Professor G. C. Foster, F.R.S.; E. Graves, Professor W. E. Hughes, F.R.S.; W. H. Preece, F.R.S.; Alexander Siemens, C. E. Spagnoletti, A. Stroh, and Sir William Thomson, F.R.S. The first meeting of the committee was to have been held yesterday, the 19th instant, at 4:30 p.m.

ELECTRIC LIGHTING IN NEW YORK.—The contracts for lighting New York from the 1st of this month have been decided on. The United States Electric Light Company are to light the Battery Park, City Hall Park, Broadway from Canal-street to Fourteenth-street, Washington-square, and Fifth-avenue from Washington-square to Fourteenth-street with 65 lamps, at the rate of 70 cents per lamp per night. The Brush Company are to light Broadway and Fifth-avenue from Fourteenth-street to Thirty-fourth-street, Fourteenth-street from Fourth-avenue to Fifth-avenue, Thirty-fourth-street from Broadway to Fifth-avenue, and Union and Madison-squares with 61 lamps, at the same price, viz., 70 cents. per lamp per night. The other contracts for the remaining districts of the city were given to the gas companies.

COMMUNICATION BETWEEN ENGLAND AND FRANCE.—In the House of Commons on Monday Sir E. Watkin asked the

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Postmaster-General whether the concession to the Submarine Telegraph Company for laying cables between England and France would bar the Post Office from assenting (with or without the concert of the French Government) to the laying of cables between the English coast and the Varne lightship, and the lighthouse on Cape Grisnez for the special purposes of enabling shore warnings to be given in cases of ships in distress in the Channel; and whether, if private persons were ready at their own cost to lay any such cables, he would give consent accordingly.—Mr. Fawcett, in reply, said that the concession held by the Submarine Telegraph Company did bar the Post Office from assenting to the laying of such cables as those referred to.

Electric Light in Milan.—The Café Biffi, in the Victor Emmanuel Gallery at Milan, is now regularly lighted by Edison incandescent lights, fifty-seven A lamps being used. The dynamo used to generate the current is the same as was lately employed when the *foyer* of the Scala Theatre was lit by Edison lamps for twenty-three nights, the machinery not having been removed. The Café Biffi is some 500 metres distant from the dynamo. The lights have been going for over a month now, and have given great satisfaction both to the proprietor of the café and the public. The arrangements were carried out by Mr. James Shepherd, agent for the Edison Company in Milan. We are informed that a company has been formed in that city to work Edison's patents, and that his lights will probably be shortly introduced into several public and private establishments.

A Submarine Telegraphic Entertainment.—Under the above title Mr. F. C. Webb, well known as having been intimately connected with the laying of many cables, announces that he will give a descriptive lecture on cable laying in St. George's Hall, Regent-street, on the 31st May at 2:30 p.m. The entertainment will consist of a *vivâ voce* explanation of the *modus operandi* of laying submarine cables, with some historical remarks, illustrated by coloured diagrams, on various ships that have taken part in cable-laying expeditions. It will conclude with a practical demonstration of how to make a splice, in which Mr. Webb will be assisted by men experienced in the work, he himself assuming the position, to which he is by no means unused, of "Engineer-in-Charge." Further information as to tickets, &c., can be had of Messrs. Mitchell and Son, 36, Parliament-street, S.W., or at the hall.

International Electrical Exhibition at Vienna.—On Thursday, the 11th inst., a meeting took place in the Bourse Buildings at Vienna (Baron Erlanger in the chair) to discuss the preliminary arrangements for the International Electrical Exhibition, which is to be held during the months of September and October. It was announced that the Minister of Commerce had sanctioned the use of the Rotunda (part of the Exhibition Buildings of 1873), and that both the Ministry of Commerce and the Ministry of War will be represented in the Exhibition. Official invitations are to be issued to all the foreign Governments; the export and import of exhibits will be free of duty, and the rights of inventors protected. Local committees are already formed in Germany, France, and Holland, and a number of leading firms from England, America, and Belgium have intimated their intention of joining in the Exhibition. The general committee consists at present of 73 members, and includes professors, electricians, editors, members of Parliament, financiers, and other influential parties. Out of the general committee a central committee was formed with 25 members.

Electrical Re-lighting of Miners' Lamps.—Messrs. Durant and Hubert have invented a method of re-lighting miners' safety lamps, extinguished by firedamp, without opening them, and without removing them from the explosive atmosphere. A practical demonstration of the system before the Société des Ingénieurs sortis de l'école d'Industrie et des Mines du Hainaut was regarded as satisfactory. Into the bottom of the lamp are fitted two plugs of wood, containing and insulating two copper wires, which are connected by a short platinum wire passing close to the wick. The ends of the wires are connected with the poles of a battery, so that on making contact the current raises the platinum wire to incandescence and lights the lamp. In order to prevent the production of sparks, on breaking contact, which would ignite the explosive mixture due to the presence of firedamp, the electrodes are kept clear of the fluid by means of spiral springs, and are only immersed in it by pressing the lamp upon them when it is to be lighted. The bichromate of potash battery has been selected, as being portable and, at the same time, powerful; and, to increase its energy, two zinc and four carbon plates are used. It is also proposed, eventually, to use a Daniell battery.

Consolidation of Electric Light Companies in America.—About a year ago the Gramme Electrical Company was formed by a combination of the leading companies owning patents for arc lights and machinery for generating electricity for such use. Recently the combination has been strengthened by union with the Edison Company, thus giving the Gramme Company control of all the leading systems of electric lighting. The combination now comprises the American Electric Company, the Brush Electric Company, the Edison Electric Light Company, the Fuller Electrical Company, the Jablochkoff Electric Lighting Company, the United States Electric Lighting Company, and the Weston Electric Lighting Company, in addition to the original company owning the Gramme patents. Before the last consolidation the Gramme Company controlled all the patents for working arc lights, and now it practically monopolises incandescent lighting also. The combination would appear to have been made chiefly to prevent litigation between the combining companies and to facilitate the suppression of organisations not in the ring by litigation, or competition, purchase, or otherwise.—*Scientific American.*

The "Retriever."—The following information is taken from the *Panama Star and Herald* of the 11th March last, and gives some information as to the movements of this cable ship, which is supplementary to that given by us some few weeks ago. Our contemporary says:—"The repairing steamer 'Retriever,' belonging to the West Coast of America Telegraph Company, under the command of Captain Morton, arrived in this bay early yesterday morning (Friday, March 10, 1882). She is at present engaged by the well-known submarine cable manufacturers, the India Rubber, Gutta Percha, and Telegraph Works Company, of Silvertown, London, to make the preliminary survey of soundings, &c., for the proposed extensive system of cables which this firm has undertaken to lay for the Central and South American Telegraph Company of New York. Mr. E. W. Parsoné is entrusted with this portion of the work, assisted by Mr. R. K. Gray, Mr. G. A. Darling (analytical chemist), and Mr. C. T. Hawkins (draughtsman). The 'Retriever' will leave at an early date to complete the survey between this port and Salinas Cruz, Mexico. Mr. Robert Kaye Gray may be expected to arrive on the Isthmus about the 22nd of this month. This gentleman has entire charge of this big undertaking, both at home and abroad."

The Telephone in Brazil.—According to to the *Anglo-*

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Brazilian Times, the telephone was first introduced into Brazil in 1877. The first telephone was constructed at Rio de Janeiro, in the workshops of the Western and Brazilian Telegraph Company, under the direction of Mr. France. A short time afterwards, towards the end of 1877, Messrs. Rodde and Co. established a telephone line between their offices and the Rio Exchange. In 1879 the Telephone Company of Brazil, formed at Boston, obtained a concession for a telephonic line to Rio and Nitheroby; but, owing to delays due to the supineness of the Government, the company did not commence operations until the 28th May, 1881, with three lines of 1,500 metres long. From that time the extension of the system was so rapid that in ten months the company had constructed 600 kilometres of telephone lines in Rio and the provinces. At Rio de Janeiro also the company have eight telephone offices open to the public. The longest of the lines is 28 kilometres long. It is the precursor of one of longer extent—viz., one that will unite Rio to Pretropolis. In the interior of Brazil the planters make great use of telephone lines between the different portions of their plantations, other plantations, the railway stations, and the doctors' residences, &c. Several railway companies have also adopted the company's telephones.

The Atlantic Cable Companies.—An extraordinary general meeting of the Anglo-American Telegraph Company will be held at the Cannon-street Hotel, E.C., on the 25th May, at noon, to confirm and adopt an agreement made between this company, the Direct United States Cable Company (Limited), La Compagnie Française du Télégraphe de Paris à New York, and the American Telegraph and Cable Company, with respect to the division and appropriation of the joint traffic receipts. By this agreement, taken in connection with the existing agreements, the joint traffic receipts of the four companies will become divisible in the following proportions:—From the date at which the American Telegraph and Cable Company shall have one cable in complete working order and condition, and regularly opened for traffic, 55·125 per cent. to the Anglo Company, 18·375 per cent. to the Direct Company, 14·000 per cent. to the French Company, 12·500 per cent. to the American Company, and from the date at which the American Telegraph and Cable Company shall have two cables in good working order and condition, and regularly opened for traffic, the division of traffic receipts will be in the following proportions:—48·825 per cent. to the Anglo Company, 16·275 per cent. to the Direct Company, 12·400 per cent. to the French Company, 22·500 per cent. to the American Company. The above division of traffic receipts is subject to certain modifications in the event of interruption of the respective cables. An extraordinary general meeting of the Direct United States Cable Company will also be held at the same place, at 2 p.m., with the same object.

Magnetic Properties of Steel.—In a recent number of *Wiedemann's Beiblätter* the results of some experiments made by Herr Poloni to ascertain the permanent magnetic properties of steel at different temperatures were recorded. The rods under trial were cylindrical, and passed in a vertical direction through an induction coil. It was ascertained that, in order to assume the permanent magnetism corresponding to a certain temperature, the rod required a somewhat longer time for cooling than for heating. The greater the total decrease of the magnetism, the longer the time necessary. The number of successive heatings and coolings required to permanently magnetise the rod were nearly proportional to the permanent decrease of the initial magnetism. The greatest loss was between 170°—200°C. When the rod is hot every shock occasions a decrease in the magnetism, but after repeated agitations and heatings the rod undergoes no permanent changes. The distribution of the magnetism in long rods was likewise examined according to the methods of Van Rees. In his formula for the moment, M, at x points distant from the end, $M = a\,(1 + k^{-1} - k^{-x} - k^{(1-x)})\,x\,l$, where l denotes the length of rods and a and k are constants, it appeared that under certain circumstances k was constant at all temperatures for the same magnet, while a varied with the temperature. Below 180°C. the distribution of the magnetism was no longer variable, that is, the value of k remained constant, and the neutral line was always in the middle of the rods. Above 180°C. the same thing took place if the rod had been repeatedly heated before being magnetised. But if it had been magnetised before the heatings and coolings, k varied with the temperature, and the neutral line was displaced towards the north pole, so that austral magnetism extended over two-thirds of the rod.

The Telegraph in South Australia.—Alluding to the necessity for a transcontinental railway for Australia Mr. Thomas Harry writes as follows of the telegraph system in South Australia in a paper on that colony, recently read before the Royal Colonial Institute:—"Whenever," he says, "the work is carried out, its practicability will be much facilitated by the existence of that great work of which South Australia is so justly proud—namely, the Overland Telegraph. Immense as would be the benefits which a line of railway would confer in developing the resources of the Australian continent, it is doubtful whether they would exceed those which the centres of Australian trade and commerce enjoy as the result of the labours of those far-seeing men, Sir James Ferguson, Mr. H. B. T. Strangways, and others, who in spite of all opposition caused the telegraph to be taken across 2,000 miles of what were then pathless wilds, and brought the producers and factors of our leading Australian staples within speaking distance of the European markets. It has further served as the basis of all subsequent explorations, prevented the abandonment of the central country, and led to its gradual occupation for pastoral purposes. The main facts of the history of that enterprise are known to many of you, and are well set forth in Mr. Harcus's work on South Australia. It is five-and-twenty years since the desirability of connecting Australia with Europe by wire was first suggested, but the Colony was then too young to carry a scheme of such magnitude into practical effect. Five years later, on the return of Stuart, the explorer, from his adventurous journey right across the Continent, the idea was again revived, but it was not till 1870 that any practical steps were taken to execute the work. After some further delay, the first pole was planted at Port Darwin in September, 1870, but the whole line was not completed until August 22, 1872. Extraordinary difficulties presented themselves, but the work was successfully carried out under the able and energetic direction of Mr. Charles Todd, the Superintendent of Telegraphs. The length of the wire from Port Darwin to Adelaide is 1,916 miles. The total cost was about £450,000, the annual interest on which is by no means recouped by the receipts; but the indirect benefits to the Colony are immense. A member of the Legislature, who had opposed the Telegraph Bill, has since stated that within six months after the opening of the line the Colony netted nearly a quarter of a million sterling extra on their wheat harvest, through the telegraph enabling sales to be made in foreign markets, and facilitating the chartering of ships to convey the produce to Europe."

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THEORY OF MAGNETO AND DYNAMO MACHINES.

XIII.

By means of this somewhat long preliminary we have got the ground pretty clear, and can now give the theory of the magnetic production of currents without much trouble.

But we warn the student that this part of the subject is not exactly after-dinner reading, and that he must make up his mind to work at it if he means to learn anything; and more especially we must warn him that all that has been written in the preceding articles will be supposed known, and will be quoted without special reference; so that he will do well to refresh his memory by reading connectedly the whole of those articles, paying *particular* attention to the following parts:—

Art. II., December 17, 1881.—All about lines of force and intensity of a magnetic field.

Art. III., December 24.—Behaviour of a circuit carrying a current in a magnetic field.

Art. IV., January 7, 1882.—Theorem at the beginning concerning the change in potential energy of a moving circuit, and the whole article.

Art. V., January 14.—First column.

Art. VI., January 21.—The whole, if the preceding articles have not been clear.

Art. XI., March 18.—Electromotive force, and energy of current.

Art. XII., April 1.—Ohm's and Joule's laws.

Work Done by a Revolving Coil.

Consider a circuit of area A, put in a uniform field of intensity I, with its plane along the lines of force (so that none of them pass through it); it experiences a couple, tending to turn it through a right angle, equal to γ A I; and the work it can do in turning through the right angle is also γ A I; in other words, it is equal to the strength of the current (supposed constant) multiplied by the total number of lines cut.

Rate at Which the Spinning Coil Does Work.

Let the rotation through the right angle take place in the time t, then the *average* rate at which the work is done is

$$\frac{\gamma A I}{t};$$

and by making t small, this quotient can be made large.

The *actual* rate, however, varies during the rotation; to find the actual rate in any position we must only rotate through a small angle $d\,\theta$.

Let the normal to the plane of the coil at any instant be inclined to the positive direction of the lines of force by an angle θ (the tendency being to make $\theta = 0$); the number of lines passing through the coils is

$$I A \cos\theta;$$

the change in this number for a small angular rotation, $-d\,\theta$, is

$$I A \sin\theta\, d\theta;$$

the work done is

$$\gamma I A \sin\theta\, d\theta;$$

and, if this be done in the time $d\,t$, the rate of doing work is

$$\gamma I A \sin\theta \frac{d\theta}{d t};$$

$\frac{d\theta}{dt}$ being the angular velocity, which we may hereafter style ϵ.

The Four Quadrants in the Rotation of a Spinning Coil.

The work done while the above coil is rotating from any position θ_1 to any other position θ_2 is simply

$$\gamma (N_2 - N_1);$$

that is,

$$\gamma I A (\cos\theta_2 - \cos\theta_1).$$

Starting from the position when all the lines go through "wrong way" ($\theta = 180°$), let it turn through a right angle, so that none go through at all ($\theta = 90°$); the work done in thus taking all the lines out is γ I A. Let it now go on turning through another right angle till all the lines are put through right way ($\theta = 0$); the work done is again γ I A, and has the same sign as before.

If you want the coil to turn any more you must drive it yourself, and must do work γ I A upon it for each of the next two quadrants of the rotation, viz., while you are taking all the lines out and putting them in wrong again, ready to begin afresh.

Loss of Potential Energy of a Moving Circuit.

The above is a special example of the general case, viz., that whenever a circuit conveying a current of strength γ is permitted to include N more "right" lines of force, it does work equal to γ N; and whenever it is forced to include N more "wrong" lines of force (or to lose N right ones), work must be done upon it equal to γ N. Since, however, it is not obvious where or against what this work is done, and since, in fact, this depends altogether upon circumstances, it is a clearer and indefeasible statement to say that the circuit loses potential energy γ N in the former case, and that it gains it in the latter.

For instance, whatever the potential energy of the revolving coil when all the lines go through it the right way, it is 2 γ A I units greater when they all go through it the wrong way. So that at every complete revolution from the latter position it loses γ A I units of energy in turning through each of the first two quadrants, and gains the same amount in the third and fourth quadrants.

Now where does this energy go to, and come from? If the rotation is resisted so that it turns quite slowly against friction, the energy lost will appear as external heat. If it is resisted by a spring, or a crank, or other mechanism, so as to turn quite slowly, the energy lost may appear as a bent spring, or raised weight, or other form of mechanical energy. If allowed to turn quickly against no external resistance whatever the energy appears as the kinetic energy of the moving circuit when it is flying past its equilibrium position and overshooting itself into the potential form again—like a pendulum. But in each case the mechanical energy is produced at the expense of the current, or rather of the battery which is supplying the current; hence either the current must be weakened by the motion, or the battery must be called upon to do extra work. The former is the case in quick motions, the latter in slow. But all this we must now investigate.

Case of a Stationary Circuit.

Let E be the E.M.F. of the battery, γ the strength of the current, and R the resistance of the whole circuit, then the energy of the current, or the work done by the battery in the short time $d\,t$, is

$$E \gamma\, d t.$$

A certain quantity of heat must be produced in the battery and rest of the circuit by the current, and the mechanical equivalent of this heat according to Joule's law is

$$R \gamma^2\, d t.$$

Now if no motion of the circuit or of magnets in its neighbourhood is allowed to take place, so that the number of lines of force passing through it is unaltered, there is no other form of energy but heat produced, and accordingly we must have

$$E \gamma\, d t - R \gamma^2\, d t = 0,$$

or,

$$R \gamma = E,$$

i.e., the electromotive force of the battery is the whole E.M.F. in the circuit.

This equation is no mere re-statement of Ohm's law. For, observe that R γ is the E.M.F. necessary to drive the current γ through the resistance R (by Ohm's law), and E means the E.M.F. of the battery; so when the equation asserts that R γ = E, it tells us the important fact that, in a circuit in which there is no motion with reference to the lines of force, there is no internal E.M.F.; but that the current is produced simply and solely by the external or "impressed" E.M.F. of the battery applied. [We are not here supposing that E is necessarily constant. The E.M.F. of even voltaic batteries depends somewhat upon the current

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they are producing, the E.M.F. of dynamo machines depends enormously upon the current they are producing; but all we have said remains true for any kind of current generator, treated as an external E.M.F. applied to a circuit.]

Case of a Moving Circuit.

But now suppose that by reason of any small motion whatever the number of lines of force passing through the circuit (or the negative potential of the circuit) increases in the time $d\,t$, by the small amount $d\,\mathrm{N}$, so that the circuit loses energy equal to

$$\gamma\,d\,\mathrm{N},$$

what will happen?

The work done by the battery is, as before, $\mathrm{E}\,\gamma\,d\,t$, the heat generated, as before, is $\mathrm{R}\,\gamma^2\,d\,t$; but these two quantities do not exhaust the whole of the energy transaction, and they are no longer equal to one another; but

$$\mathrm{E}\,\gamma\,d\,t - \mathrm{R}\,\gamma^2\,d\,t = \gamma\,d\,\mathrm{N},$$

their difference equals the work done in the circuit itself.

This tells us, then, that

$$\mathrm{R}\,\gamma = \mathrm{E} - \frac{d\,\mathrm{N}}{d\,t}.$$

Now what does this mean?

$\mathrm{R}\,\gamma$ is by Ohm's law the total E.M.F acting in the circuit, but it is now no longer equal to the E.M.F. of the battery. The total E.M.F. is less than E by the amount $\frac{d\,\mathrm{N}}{d\,t}$, the rate at which lines of force are added to the circuit per second, or the rate at which the potential of the circuit is decreasing.

The difference between the applied E.M.F., E, and the resultant E.M.F., $\mathrm{R}\,\gamma$, must be of the nature of an opposition E.M.F., e—

$$\mathrm{E} - \mathrm{R}\,\gamma = e;$$

but by the above equation

$$\mathrm{E} - \mathrm{R}\,\gamma = \frac{d\,\mathrm{N}}{d\,t},$$

therefore, $\frac{d\,\mathrm{N}}{d\,t}$ is a measure of, and is numerically equal to, an opposition E.M.F. produced in the circuit as a result of the motion.

Putting it in another way. Applying Ohm's law to the circuit, we have no longer

$$\frac{\mathrm{E}}{\gamma} = \mathrm{R},$$

but

$$\frac{\mathrm{E} - \frac{d\,\mathrm{N}}{d\,t}}{\gamma} = \mathrm{R};$$

that is, the current is weaker than what the battery could produce in a stationary circuit: weaker not by reason of any increase in resistance, but by reason of an opposition E.M.F.

$$\frac{d\,\mathrm{N}}{d\,t}.$$

Now this is a most important result, because it shows how the phenomena of magnetic and current induction, discovered experimentally by Faraday in 1831, can be deduced theoretically by applying the principle of the conservation of energy to the electro-magnetic actions exerted between currents and magnets which were discovered and investigated by Œrsted and Ampère.

Sense of the Opposition E.M.F.

We have seen that when the circuit carrying a current is allowed to move as it wishes in a magnetic field—that is, when it moves so as to increase the number of lines of force passing through it in the right direction (the "right" direction meaning the same as that of the magnetic lines the current itself produces), or so as to decrease the number of lines passing in the wrong direction, in other words, so that the potential of the circuit decreases,* then the E.M.F. $\frac{d\,\mathrm{N}}{d\,t}$ is in opposition to the battery current which produces, or helps to produce, the motion. And the E.M.F., by thus weakening the battery current, does all it can to oppose the motion. This is Lenz's law.

* Remember that the potential energy of a current is $-\gamma\,\mathrm{N}$, not $\gamma\,\mathrm{N}$.

It is by no means essential that the whole motion shall be produced electrically. Suppose it is turned by hand in the same direction as the current would turn it, the same equation will apply exactly,

$$\mathrm{E}\,\gamma\,d\,t - \mathrm{R}\,\gamma^2\,d\,t = \gamma\,d\,\mathrm{N},$$

or

$$\mathrm{E} - \mathrm{R}\,\gamma = \frac{d\,\mathrm{N}}{d\,t};$$

but the opposition E.M.F., $\frac{d\,\mathrm{N}}{d\,t}$, may be now made very large by turning quickly—*i.e.*, by decreasing $d\,t$, and may equal the battery E.M.F. itself, in which case there will be no current for the instant; or it may overpower it, and drive a reverse current.

It is plain, then, that the battery force E is quite immaterial to the action, the induced or internal E.M.F., $\frac{d\,\mathrm{N}}{d\,t}$, developed by the motion, depending in no way on its value; hence the battery may be removed (the wires being joined up, of course), and the same equation will apply, with $\mathrm{E} = 0$. That is,

$$-\,\mathrm{R}\,\gamma = \frac{d\,\mathrm{N}}{d\,t}.$$

In this case the current, γ, is produced entirely by the motion; there is no other electromotive force acting at all. The motion in the magnetic field is by itself able to produce a current whose strength is numerically

$$\frac{\frac{d\,\mathrm{N}}{d\,t}}{\mathrm{R}};$$

and this induced current is always in such a direction as to oppose the motion.

DIP AND SPAN TABLES FOR TELEGRAPH WIRES.

BY R. VON FISCHER-TREUENFELD.

A telegraph wire suspended between two supports of equal height forms a curved line, "the catenary," depending upon the following conditions:—

S = span, or direct distance between the two supports.
l = actual length of wire between the two supports.
d = dip of wire.
W = weight of one foot of wire.
b = tension of wire at the lowest point of the curve.

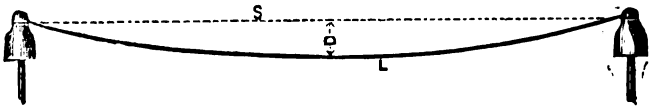
The mathematical deduction of these unknown quantities is to be found in many text-books of telegraphy, and the following equations only relate to the practical calculation of dip and span, viz.:—

(1) . . . . . $d = \dfrac{\mathrm{W}\,.\,\mathrm{S}^2}{8\,.\,b}.$

(2) . . . . . $l = \mathrm{S} + \dfrac{8\,.\,d^2}{3\,.\,\mathrm{S}}.$

(3) . . . . . $d = \sqrt{\dfrac{3\,\mathrm{S}\,(l - \mathrm{S})}{8}}.$

The following table and diagram are so arranged that the dip required for any span between 200 and 2,000 feet can be read off without calculation. A change in temperature



causes either an increase or decrease in the length (l) of the wire, the dip (d), and the tension (b). The table and diagram give the necessary allowance which must be made for any decrease of temperature after the day of the erection of any

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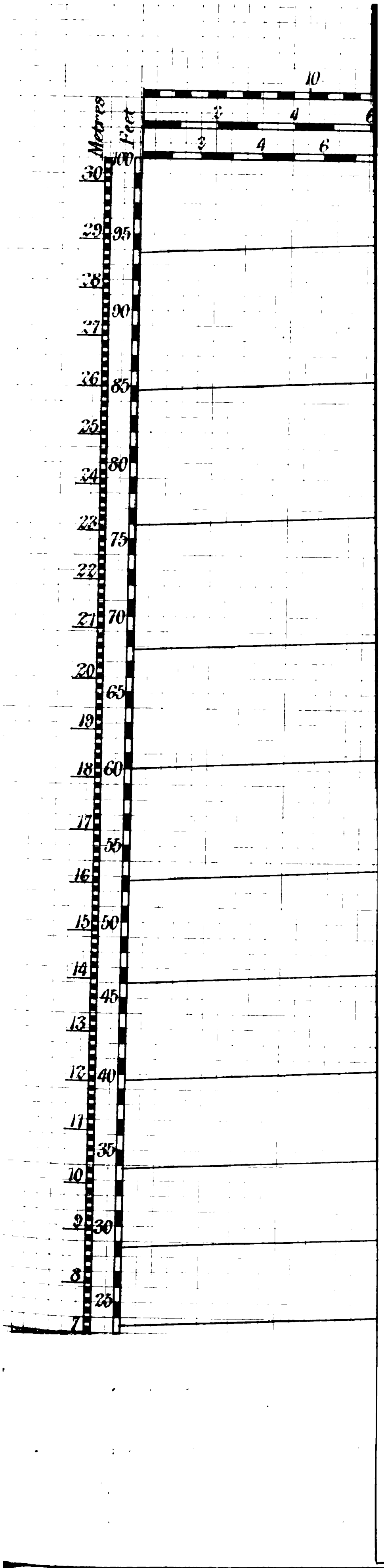

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gives the lengths and dips in feet and metres, and the temperatures in Centigrade, Reaumer, and Fahrenheit. The *modus operandi* is simple, it being only required to know

(1) The temperature during the erection of the wire.

2·90 feet, or from $11\frac{1}{4}$ inches to $34\frac{3}{4}$ inches (… and 11), which means an actual increase of th… $23\frac{1}{2}$ inches, or nearly twenty times as much … length of the wire.

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wire, the dip (d), and the tension (b). The table and diagram
give the necessary allowance which must be made for any
decrease of temperature after the day of the erection of any

Dip and Span Table for Telegraph Wires at all Temperatures and in all Countries.

Wire when at lowest probable Temperature.			Length of Wires and Dip at Temperatures above the lowest probable Temperatures.									
			10°C. above lowest Temperature.		20°C. above lowest Temperature.		30°C. above lowest Temperature.		40°C. above lowest Temperature.		50°C. above lowest Temperature.	
Span in feet.	Length of Wire in feet.	Dip in feet.	Length in feet.	Dip.	Length in feet.	Dip.	Length in feet.	Dip.	Length in feet.	Dip.	Length in feet.	Dip.
200	200·012	0·94	200·037	1·67	200·059	2·10	200·087	2·55	200·112	2·90	200·137	3·20
300	300·039	2·10	300·076	2·92	300·114	3·58	300·150	4·11	300·187	4·58	300·224	5·02
400	400·096	3·75	400·149	4·73	400·198	5·45	400·255	6·18	400·308	6·80	400·361	7·36
500	500·181	5·86	500·241	6·72	500·303	7·54	500·361	8·23	500·421	8·88	500·481	9·49
600	600·317	8·44	600·394	9·41	600·468	10·27	600·548	11·11	600·625	11·85	600·702	12·57
700	700·512	11·49	700·596	12·51	700·672	13·28	700·764	14·16	700·848	14·92	700·932	15·64
800	800·750	15·00	800·848	15·95	800·947	16·86	801·044	17·70	801·142	18·51	801·240	19·30
900	901·067	18·98	901·178	19·94	901·292	20·84	901·340	21·27	901·511	22·58	901·622	23·40
1000	1001·460	23·43	1001·583	24·36	1001·746	25·59	1001·829	26·19	1001·952	27·06	1002·075	27·90
1100	1101·949	28·36	1102·086	29·33	1102·221	30·27	1102·360	31·20	1102·497	32·09	1102·634	32·96
1200	1202·531	33·75	1202·678	34·72	1202·796	35·47	1202·972	36·57	1203·119	37·46	1203·266	38·21
1300	1303·216	39·61	1303·380	40·59	1303·521	41·43	1303·708	42·52	1303·872	43·45	1304·036	44·36
1400	1404·020	45·94	1404·193	46·92	1404·365	47·87	1404·539	48·82	1404·712	49·74	1404·885	50·64
1500	1504·945	52·73	1505·135	53·82	1505·320	54·70	1505·515	55·69	1505·705	56·65	1505·895	57·58
1600	1606·000	60·00	1606·197	60·98	1606·395	61·94	1606·591	62·89	1606·788	63·82	1606·985	64·74
1700	1707·194	67·73	1707·400	68·68	1707·606	69·63	1707·812	70·53	1708·012	71·04	1708·224	71·99
1800	1808·534	75·93	1808·752	76·86	1808·970	77·81	1809·188	78·75	1809·406	79·68	1809·624	80·59
1900	1910·045	84·60	1910·275	85·56	1910·505	86·51	1910·735	87·45	1910·965	88·39	1911·195	89·31
2000	2011·719	93·75	2011·967	94·74	2012·215	95·71	2012·463	96·68	2012·711	97·64	2012·959	98·59
1	2	3	4	5	6	7	8	9	10	11	12	13

given span. The wire must be erected under the following condition, viz., that after it has contracted to its minimum of length, under the action of the lowest temperature of the coldest winter day, the limit of tension (*b*), which represents a certain fraction of the breaking strain, must not be exceeded.

This fraction is generally one-third the actual breaking strain, and taking for illustration the P.O. standard wire, No. 8 B.W.G., of ·170-inch diameter, with a weight of 396lb. per statute mile, and 1,200lb. actual minimum breaking strain, the maximum tension (*b*) of the suspended wire, during its lowest winter temperature, ought not to exceed $b = 400$lb. The weight of 1 foot of this wire is $W = 0{\cdot}0751$lb.

The first vertical column of the table gives the spans or distances (S) between wire supports ranging from 200 to 2,000 feet; the second and third columns give the length (*l*) and dip (*d*) of the wire at one-third the actual breaking strain, with which the tension (*b*) is identical. These give the lengths and dips of wires when exposed to the lowest winter temperatures, and all other lengths (*l* at 10 degrees, *l* at 20 degrees) and dips (*d* at 10 degrees, *d* at 20 degrees), and running through 10, 20, 30, 40, and 50 degrees above the lowest probable temperatures of any climate, are calculated in such a manner that, after the wire contracts to its minimum length at the lowest winter temperatures, the tension (*b*) is exactly equal to one-third the actual breaking strain of the wire.

The co-efficient of expansion by heat for iron is $a = 0{\cdot}0000123$ for 1 degree Centigrade. The expansion is proportional to the length and also (within certain limits) to the increase of heat—that is to say, 10 millions of feet of iron wire expand 123 feet at each increase of 1 degree Centigrade. The increased lengths (l^1) of suspended wires are $l^1 = l\,(1 + a\,t)$, t representing the number of degrees Centigrade of increased temperature.

The vertical columns 4, 6, 8, 10, and 12 show these increased lengths of wires, after an increase of 10, 20, 30, 40, and 50 degrees Centigrade above the lowest winter temperature, and columns 5, 7, 9, 11, and 13 give the dips corresponding to these increased lengths of wires, and calculated by Formula No. 3.

The results of the table are graphically shown in the diagram, which, in order to render it applicable to all cases, gives the lengths and dips in feet and metres, and the temperatures in Centigrade, Reaumer, and Fahrenheit. The *modus operandi* is simple, it being only required to know

(1) The temperature during the erection of the wire.

(2) The lowest probable winter temperature of the locality where the wire is being erected.

Supposing it is required to erect a span of 800 feet in the South of England; the temperature of the day + 10 degrees Centigrade, lowest probable winter temperature − 5 degrees Centigrade; hence the wire would cool 15 degrees Centigrade from the day of erection to the coldest winter day. The ordinate of the diagram contains the degrees of increased heat over lowest winter temperature, and the abscissa shows the corresponding dips. Following the 15 degrees Centigrade vertical line in the diagram until it crosses the curve which represents 800 feet span, and projecting the crossing point towards the left edge the required dip can be read off = 16·5 feet. With this dip this particular span may cool 15 degrees Centigrade below the temperature at the time when it was erected, without the tension of the wire exceeding one-third the actual breaking strain.

Supposing this same span to be erected in England at a summer temperature of 20 degrees Centigrade, it would then be liable to cool 25 degrees Centigrade, and should be allowed a dip of 17·5 feet. If, on the other hand, the same span be erected at the same temperature in the North of Russia, viz., + 10 degrees Centigrade, and where − 25 degrees Centigrade would be the lowest winter temperature, the wire would then be exposed to 35 degrees Centigrade of cooling, and in this case the dip must be 18⅓ feet. Should it be erected in North Brazil at the same temperature of + 10 degrees Centigrade, the lowest probable temperature in that country being + 5 degrees Centigrade, the wire would only cool 5 degrees Centigrade, and the dip required would be only 15½ feet.

The dip of any given span in different countries, even when erected at the same temperature, depends upon the lowest probable temperature of that particular country. The non-observance of this fact either produces too much slack or causes the fracture of the wire during the coldest months of the year.

The table and diagram also show the proportion between dip and increased length of wire. A 200 feet span at its lowest temperature has a length of 200·012 feet, with a dip of 0·94 feet, or about 11·25 inches (see table, columns 1, 2, and 3). If this length be only increased one-tenth of a foot = 1⅕ of an inch, the dip increases from 0·94 feet to 2·90 feet, or from 11¼ inches to 34¾ inches (see columns 10 and 11), which means an actual increase of the dip equal to 23½ inches, or nearly twenty times as much as the increased length of the wire.

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The proportion between dip and increased length of wire becomes less divergent with larger spans, thus:

The length of an 800 feet span at its lowest temperature is 800·750 feet, with a dip of 15 feet (see columns 1, 2, and 3). An increased length of one-tenth of an inch gives a dip of 15·95 feet (see columns 4 and 5), equal to an actual increase of dip of 11·5 inches, or only 9·5 times as much as the increased length of the wire span. From Formula (1), $d = \frac{W \cdot S^2}{8 \cdot b}$, it follows that the dip is practically the same for wires of different diameters, and of the same kind and quality. Hence the above table and diagram, calculated for a No. 8 B.W.G. wire (Post Office standard), will serve for iron telegraph wires of any size, although the results are only approximately correct.

*** The Table above referred to forms the Supplement to this week's *Electrician.*

CORRESPONDENCE.

CURATIVE ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In his letter to *The Electrician,* on April 29, Mr. Desmond FitzGerald says, "I make bold to assert directly and confidently that it has never yet been shown that magnetism—even as developed by the *most powerful permanent or electro-magnets—exerts any physiological action whatever.*"

This strong assertion is doubtless partially correct, but whilst admitting this much, I as confidently assert that every vital action is due to a display of that force which is known as the magnetic force; and that no other results than those named by Mr. Desmond FitzGerald could be expected from the clumsy and unscientific method which man has adopted to simulate the perfection of that mechanism which has been displayed by God in maintaining animal life.

Unquestionably physiology is the science which treats of the vital actions or functions performed by the organs of plants and animals. Natural and not exaggerated vital action must, therefore, be anticipated from the application of magnetism, if magnetism is the power which sustains vital action.

Prior to the evolution of any marked physiological action from the magnetic force, such as the spasmodic contractions of the muscles, &c., I am of opinion it would be essential that the force be converted into a current of considerable power, as in magneto-electricity. Then such phenomena would be readily elicited, and, in fact, I shall attempt to convince Mr. Desmond FitzGerald that all natural vital action is the direct outcome of magnetic power, and I am further of opinion that a knowledge of the principles of the mechanism by which vital action is maintained must afford much more reliable information as to the influence magnetism is capable of exerting in support of such vital action than the best attested cases, or the most powerful physiological action under its exhibition can supply. Nevertheless, beneficial results in cases in which it has been tried, and physiological action occurring under its influence, cannot be rejected as evidence favourable to its use. Under any circumstances the *absence of physiological* action can only be received as *negative evidence.*

As briefly as possible I will support the statement I have made that animal life is the immediate outcome of magnetic force.

1. The earth is a magnet.

2. Every form of matter has a certain capacity for this magnetic force of the earth, and the capacity varies with the molecular composition and other physical conditions of the matter.

3. Every form of matter transmits the force in lines which are characteristic of the matter. This law embraces the animate as well as the inanimate kingdoms of nature.

4. The first principles of magneto-electricity depend upon the recognition of the principle that when matter is moved through the lines of force emanating from a magnet, force is generated in the matter in a degree proportionate to the intensity of the magnetic force, the character of the matter, and the rapidity of the motion.

5. All animal life is accompanied with motion of matter, and this motion is molecular, probably atomic also. With but few exceptions, in the lower forms of animal life the moving matter is composed of a nutrient pabulum and a corpuscular portion. The latter, as shown by Dr. Gamgee, is highly magnetic both in the venous and arterial states. My paper in the *Proceedings of the Royal Society* (No. 157, 1875) proves that the arterial blood corpuscles contain more magnetic force than the corpuscles of the venous blood, a very important point, for the arterial blood sustains life, while the venous blood is incapable of doing so.

6. According to the physical laws referred to above it is impossible that the blood can move over the tissues in a state of health and through the lines of the magnetic force of the earth, which permeates every portion of those tissues, without originating in the tissues force, which must correspond in velocity with the force resulting from the motion of the magnetic power of the blood corpuscles.

7. When these tissues exist in continuous lines, as in the nerves, muscles, &c., currents of force must be generated, the rate of transmission of which must vary, other things being equal, inversely with the resistance each tissue offers to the transmission of force.

8. The nerve current or nerve power which regulates all the processes of life, mental and corporeal, is in exact proportion to the oxygenated and magnetic condition of the arterial blood; therefore, we can have no hesitation whatever in referring such nerve current to the motion of the magnetic blood corpuscles, in accordance with the principles of magneto-electricity.

9. By way of testifying to the influence which terrestial magnetism exerts upon the blood and tissues of the body, I may here mention that some years since I had a coil of wire constructed and so mounted upon a pivot that it could be rotated upon an axis at right angles to the direction of the strands of the wire when turned to any point of the compass. This coil is placed in connection with a very sensitive galvanometer, and the slightest motion upon its axis to the north or south gives a corresponding deflection of the galvanometer needle. The motion of the coil in this case gives motion to that quantity of the magnetism which it possesses in virtue of its being a portion of the mass of the earth, in a direction determined by the position of the wire relative to the lines of force, and the current is due and in proportion to the amount of mass displacement. This same law applies to magneto-electricity in general, and to *the mode in which the blood corpuscles originate force in the nerves and other tissues of the body.*

10. When artificial magnets are applied to the surface of the body, the terrestrial magnetic force passing through the body is increased in direct proportion to the power of the artificial magnets, just as the power of a permanent magnet is added to by each additional bar-magnet; but the tendency to general molecular motion must depend upon increase of molecular motion or force in the blood corpuscles, which act as the natural disturbers of that *equilibrium* of power which exists in the tissues owing to their connection with the earth's magnetism.

11. The degree of molecular motion will then be determined by the material composition of each molecule, and by this law there is reason to believe that a different description of molecular motion must take place in each form of animal life, *for as the blood corpuscles vary in shape in the different species of animal life, the particular description of motion by which they are formed must vary also.*

12. We thus further find that the primordial germ acts, as is generally supposed, as the directive agent of the force which maintains animal life, as a consequence of a *grand physical law which is common to all matter,* viz., *the directive influence which matter exerts upon force.*

13. This law may be distinctly traced from the atom to that combination of atoms existent in the blood corpuscles,

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and then to the cells of animal life, which are formed, as I have already shown, under the influence of centripetal and centrifugal force; then onwards through the vegetable and mineral kingdoms of Nature to the mass of the earth itself, where we find it in operation giving the earth its particular inclination on its axis, by means of which its orbital motions, its seasons, and its mechanical life is maintained; from thence to the sun and so onward from centre to centre in the universe; each increasing in magnitude until it culminates in some vast centre from which it would appear all law, order, and power or force must emanate.

14. A great fundamental principle is evolved from these considerations of the relations existing between matter and force in animal life, which has an enormous bearing upon the mental and bodily health of the community, viz., that material purity is essential to the proper construction of every formation, and to the manifestation of that energy with which such formations are endowed. It will be found that this law holds good, not only with the ultimate atoms of matter, but with the simple or compound molecule, the blood or other cell, and manifests itself in the due performance of all the functions of life, not excepting the mental powers, with which man, as the highest form of created being, is endowed.

I trust Mr. Desmond FitzGerald, from a consideration of the facts I have thus brought very imperfectly before him, will perceive that I have good and substantial physical grounds for making use of magnetic appliances in the treatment of disorder and disease.

I could, however, refer to numerous cases which have been treated in hospital and private practice, some of which have been dealt with under magnetism alone, others, and by far the larger number, by magnetism combined with the usual remedies, in which great benefit, so far as I could determine, was derived from the use of magnetism.

My reference to cases in this letter can only be very brief. I will mention first my experience of the influence of magnetism as tried upon my own person.

Some few years since I suffered very severely from gouty dyspepsia; the attacks of gastrodynia and cardialgia usually coming on about two o'clock in the morning. It was my practice on such occasions to take a large teaspoonful of bicarbonate of potash, from which I usually obtained relief, but I have had to repeat the dose. Desiring to try the influence of magnetism I had a band made to go round my waist, the magnets being placed over the stomach, liver, and great solar plexus of nerves. Upon the next subsequent attack, instead of resorting to the alkali I put on the magnetic band as described, and within a few minutes all the usual discomfort had vanished. Upon every subsequent occasion of a like nature, and they have been numerous, I have found almost immediate relief from a magnetic band.

I have treated in the Royal Berkshire Hospital two very severe cases of scrofulous disease of the mesenteric glands in subjects somewhat advanced in life for such a disease. These cases resisted all remedies until the treatment was supplemented by the constant application of magnets. Then the remedies began to take effect, and the patients made very good recoveries.

I have also the records of cases of acute and chronic eczema which derived marked benefit from the application of magnetism.

I have been in the habit of advising many of my patients who are liable to periodical attacks of bronchitis to wear these magnetic appliances as prophylactics, and much benefit has resulted from their use.

If Mr. Desmond FitzGerald will place himself before a tolerably sensitive galvanometer and a magnet at his back and watch the effects upon the needle of the lines of force which pass through his body each time the poles of the magnet are reversed, I think he will admit that a magnet possesses a power which he had not realised when he expressed the opinion that magnets have not "any superiority over pieces of whalebone."

There appears to be some doubt in the mind of your correspondent with reference to my meaning in my allusion to the trade aspect of the matter under consideration. I would, consequently, further add that I have always regarded the question involved in the application of magnetism as a therapeutic agent, as affecting in the highest degree the best interests of man. I have, therefore, studiously avoided importing into the consideration of the subject any element whereby it might be imagined my judgment could be warped. In obtaining my magnetic appliances from the source named in my last letter on curative electricity, I have avoided any connection with those who were trading in them. I have thus, also, been able to regulate their power to the requirements of my patients, and, above all, I have completely eliminated that very seductive influence, pecuniary benefit, for I have refused, and still do so, to receive any percentage or other benefit accruing from their sale.—Yours, &c.,

Richard C. Shettle, M.D.

Reading, May 9th, 1882.

ON STORAGE OF ENERGY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The introduction of practically useful secondary batteries has set many schemes in circulation. Although few of the promises have up to this moment been fulfilled, the time seems near when the utmost use will be made of the advantages offered by these means of storing almost any form of energy. It is not my idea to propose a new scheme, because there is no novelty in the conception, but I have made it my purpose to collect such facts which might add to the general knowledge of the subject.

Visitors to the Paris Exhibition of 1878 no doubt remember the ingenious solar engine, or sun steam engine, invented by M. Mouchot, and I refer to this particular engine because it is the only one I ever saw in operation, although we are told that many attempts have been made to turn the sun's heat into motive power, from the time of Euclid and Archimedes to Ericsson, who published his researches on this subject in 1868 (see *Engineer*, Vol. 47). Without describing the apparatus, I will only state that M. Mouchot collects the rays of the sun by means of a large conical mirror, from the centre of which a tubular steam boiler projects, and the concentrated heat of the moderate Parisian solar rays at the end of September, 1878, produced a steam pressure of from 45 to 105lbs. per square inch, and the estimated power of this boiler was three horse-power. A small engine below the huge reflector received and utilised the steam generated. The great variation in steam pressure, and the fact that the reflector must always face the sun, necessitates a very careful management of the apparatus. Thus the utilisation of sun rays in this manner is not practical, apart from the mechanical difficulties which would have to be met with in constructing solar engines of larger power.

Since 1878 the world has been enriched by most remarkable improvements, and not least in importance were the Faure accumulator and Clamond's large thermopile, designed in 1879. Now instead of turning the sun's heat into steam power, by a judicious combination of these or similar inventions we ought to be able to convert them immediately into electrical energy. Clamond's thermo-electric battery of 3,000 iron and bismuth antimony pairs, with a difference of about 280°C. between the solderings, produces an E.M.F. of 109 volts, with a resistance of 15·5 ohms (*see* "Gordon," French edition). Another similar battery of 6,000 pairs has been used to maintain the electric lights of *two* (Serrin) arc lamps, with a consumption of 10 kilog. of coke per hour. This consumption of fuel cannot be considered economical compared with the amount of energy given off in the lamps, but if we could arrange thermo-electric pairs on a large surface, heated by the sun (in certain climates) or by the waste heat of our furnaces, and cooled by the earth, water, or air, an economical mode of transforming thermal energy might be obtainable.

The principal difficulty lies in the keeping of perfect contacts between the hot joints, or solderings, owing to the unequal expansion of the different metals; and another drawback to the efficiency of large thermopiles is the oxidation of surfaces.

At the Paris Electrical Exhibition I made a diligent search

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after thermo-electric batteries, and found the following systems represented:—Bequerel, Clamond, Delaurier, Dubos, Gaulard, Melloni, Nobili, Noé, and Mr. Partz's, of Philadelphia, who placed a new battery in the Exhibition not many days before the same closed, without (to my knowledge) untying the brown paper in which the invention was wrapped. M. Sudre omitted to exhibit his inventions, and there are several English patentees of thermo-electric apparatus, but none was to be found at Paris, nor at the Crystal Palace, and I write this letter with the hope that experimentalists may be encouraged to come forward with the results of their researches for the benefit of science.

Apologising for my trespassing upon the valuable space of your excellent paper—Yours, &c.,

A. Reckenzaun, M.E.

Leytonstone, May 16, 1882.

THE RELATION OF GRAVITY TO ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Having read with great interest the letters by R. D. Shettle, M.D., on "What is Electricity?" it appears to me, from his last letter, that he will be able to demonstrate the relation of gravity to electricity. The subject is of great importance, and I wish him every success, and do not wish to detract from him the merit he deserves.

Having given a great portion of time to the investigation of magnetism and chemical force in the year 1876, to my mind the problem of the above-mentioned relationship was solved, but before making any statement I considered it prudent to find out if the penetrating researches of Faraday had not included this, and in Vol. III. of Faraday's works, page 161, is a description of the experiments this great discoverer carried out, and which dates July 19, 1850. He concludes with this statement:—"Here end my trials for the present. The results are negative. They do not shake my strong feeling of the existence of a relation between gravity and electricity, though they give no proof that such a relation exists."

Encouraged by this I ventured in a lecture delivered before the Bristol Mining Institute on February 24, 1877, to state my discovery. This lecture was afterwards published in the *Hereford Times*, and copied by some of the papers in the United States. Letts and Co. published it in the form of a small pamphlet.*

The method of demonstrating this truth that I selected was the formation of the diamond by decomposing carbon tetrachloride. The year 1878 was devoted to this purpose. My *success* in this direction made me more cautious and silent until the Scotch chemist (whose name I forget) demonstrated the formation of the diamond before the Royal Society, ill health having previously and since delayed my progress. But there appears to be no impossibility of producing a diamond from $\frac{3}{4}$in. to 1in. in thickness. I easily overcame the difficulty of obtaining the required high temperature, but the pressure not so easily, and the process requires courage with caution.

According to my method of demonstrating this truth, chlorine must be electro-negative as compared with oxygen, ("Correlation of Physical Forces," page 271), and potassium the same with lithium. The latter Dr. Paget Higgs informed me he had proved by experiment. The words used by Dr. Shettle, by which I saw he possessed the knowledge of what I had hitherto believed, or, perhaps, to speak more truthfully, vainly supposed was held by myself alone, are these:—"Then there must reside in the matter some force by which mass accumulation is affected, the removal of which must permit the expansion of the atoms, and of the mass as a whole." "This power must reside in the elementary atoms." "Then we are bound to admit that the atoms have been subject to a force which has compressed the atoms in a definite direction, and this direction must accord with the line of greatest density," and his next paragraph on crystallisation.

I have previously mentioned my attention to the formation of crystals (which has been a great help) which, with Plücker's inference with regard to the relation between the *forms* of the ultimate particles of matter and the magnetic forces, together with the idea of definite structure of the ultimate particles of matter as described by J. P. Cooke, the comparative weights and the comparative area of surface, as it relates to density, led to the same conclusion, viz., that the universe consists of matter and energy, that when energy takes the action of gravitation or cohesion electric energy passes from the matter acted upon, and by the removal of the force by which mass accumulation is affected electric energy passes to the matter acted upon. It is the difference or change of direction that determines whether we call it electric energy or gravitating energy. The sharp criticism which your correspondents display from week to week on such terms as potential, force, energy, &c., renders it difficult to express a term from which a great difference of opinion may not arise, especially when examined by the exacting mathematician.

Therefore, when considered as the same force, gravitation and electricity are terms which imply opposite direction; but when regarded as two forms of energy they are balancing forces or opposing forces, and it is admitted that "there is no known case of one form or part of a dual power existing otherwise than with and in dependence on the other, which then exists simultaneously to an equivalent, *i.e.*, an equal degree."

The theory of the æther assists the mind in comprehending the action of these physical lines of force, and the breaking up of masses of matter changing the lines of force into curved lines of force on the ultimate atoms. Showing the change from the static to the dynamic condition will require more space in your valuable paper than you will be disposed to give me this week, and the same remark applies to an explanation of magnetic action which can be demonstrated by the same laws, and which I have no doubt Dr. Shettle will also give us in his future letters.

Notwithstanding the strong impulse to believe the problem is solved, and the help I have derived from this theory during the past five years, I fully appreciate Faraday's words, "It is better to be aware or even to suspect we are wrong than to be unconsciously or easily led to accept an error as right," remembering that "the oretic conceptions are incessantly checked and corrected by the advance of knowledge."—Yours, &c.,

W. Blanch Brain.

St. Annals, Cinderford, April 19, 1882.

* A copy of the lecture referred to I send by this post for your inspection.

The Electric Light in Mull.—Several successful trials of the electric light have been made at Carsaig, the seat of A. J. Maclean, Esq., of Pennycross, in Scotland. The motor employed was a small turbine supplied by Messrs. Gilkes, of Middlesborough, to utilise the power of one of the many waterfalls which are to be found on Mr. Maclean's estate. The general result of the trials has been that with 25ft. of fall the water led on to a 7in. through $4\frac{1}{2}$in. piping supplied sufficient motive power when opened $\frac{7}{8}$, $1\frac{1}{8}$, $1\frac{1}{4}$, $1\frac{1}{2}$, and $2\frac{1}{2}$ inches, to light 1, 2, 3, 4, and 5 Swan lamps respectively; and at the last-named point to work one Brush arc lamp of 2,000 candle-power. This lamp placed on one of the crow-step gables of the farm-steading lighted the fields around for a distance of fully 200 yards with great brilliancy; and with a reflector, objects at much greater distance, such as the waterfalls on the hillside, sheep, &c., were made visible. On two successive evenings the incandescent lights did duty in-doors while the family were at dinner. The Swan lamps were lent by Messrs. Anderson and Munro, of Glasgow, and the other appliances, including Lane-Fox lamps, by the Brush Company of Scotland, through Mr. Mackie, their able manager in Leith. Mr. Maclean, we learn, was thoroughly satisfied with the light, and is taking early steps to have it permanently at Carsaig. The data of the trials have been carefully noted by Mr. Maclean, postmaster, of Oban, who, we believe, intends to publish them.

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SOUTH AMERICAN CABLE WORK.

We have from time to time spoken of the manufacture, and of the ships used in laying a new cable for the Central and South American Telegraph Company. The cable has been manufactured by the India Rubber, Gutta Percha, &c., Company, at Silvertown, under the able superintendence of Mr.

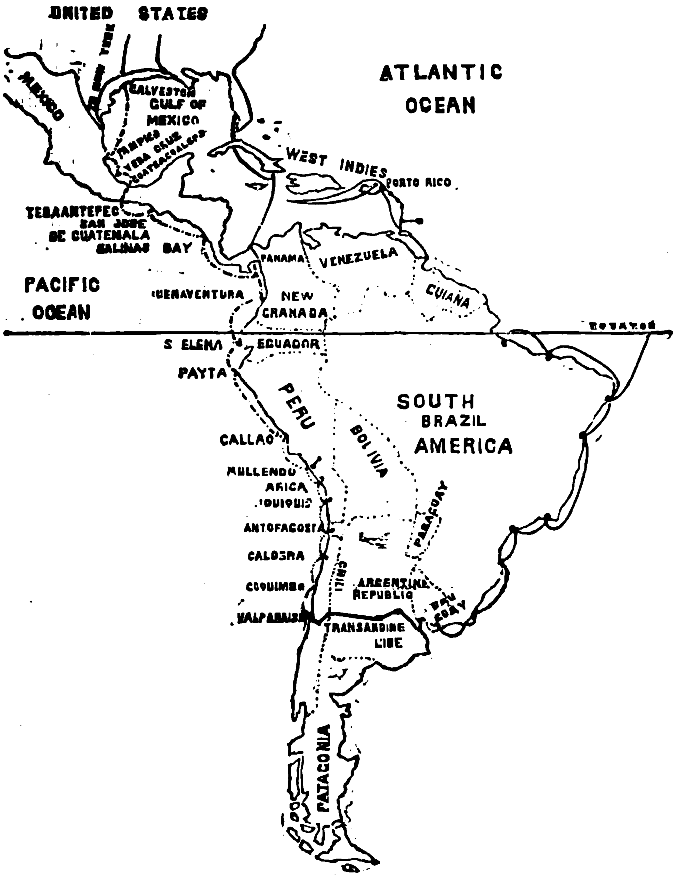

Fig. 4.—Sketch Map.

Gray. The contract was for more than 3,000 miles of cable, consisting of three types—shore end (Fig. 1), weighing 14·64 tons per mile; intermediate cable (Fig. 2), weighing 4·31 tons per mile, and main, or deep sea cable (Fig. 3), weighing 1·6 tons per mile. The breaking strain of the main cable is 5·5 tons. The sketch map (Fig. 4) shows the cable connections in South America as they will be when this line is completed.

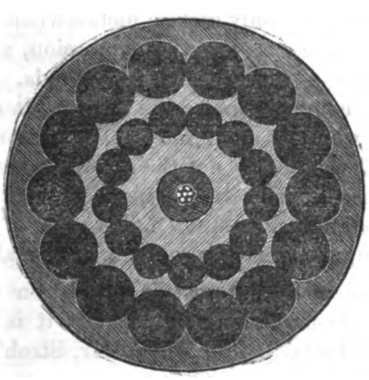

Fig. 1.—Shore End.

There will then be uninterrupted communication from North America *viâ* the Mexican Gulf to Valparaiso. It is hoped that the cable will be completed next month. The various station houses, 42ft. by 22ft., have, we believe, also been supplied by the Silvertown Company, as well as the whole electrical apparatus required, and the other fittings. The same firm has also supplied the materials for the land lines. We hope in a future number to describe the laying of these cables, as although it is stated that for the most part the cables will be in shallow water, and the work comparatively simple, there is always something to be learnt from such

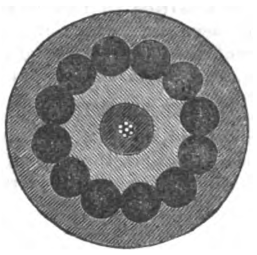

Fig. 2.—Intermediate.

operations. Mr. J. B. Stearns, the South American Telegraph Company's chief engineer, has certified that the whole cable is in all respects in accordance with the contract specifications. We had the pleasure of witnessing the manufac-

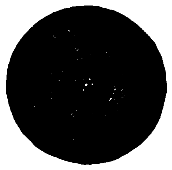

Fig. 3.—Deep Sea.

ture of some portion of this cable, and we cannot but congratulate Mr. Gray upon the excellent manner in which the manufacture, shipment, and, so far, the laying operations, have been carried out.

New Companies.—Within the past few days the following electric light companies have been floated, viz.:—The Birmingham and Warwickshire (Brush) Electric Light and Power Company, with a capital of £100,000; the Metropolitan (Brush) Electric Light Company, with a capital of £1,000,000; the Provincial (Brush) Electric Light and Power Company, with a capital of £200,000; the Devon and Cornwall (Brush) Electric Light and Power Company, with a capital of £100,000; South African (Brush) Electric Light and Power Company, with a capital of £100,000; the Australasian (Brush) Electric Light, Power, and Storage Company, with a capital of £255,000; and the Staffordshire and Worcestershire (Brush) Electric Light and Power Company, with a capital of £200,000. The Phœnix Electric Light and Power Company, with a capital of £250,000, has been started to work Mr. FitzGerald's lamps and dynamo machine. The Anglo-Pacific Electric Light, Telephone, and Power Company has been started to work the respective electric light and telephone systems of the Brush Company, Professor Dolbear, Mr. Edison, Professor Graham Bell and others, with a capital of £300,000, on the West Coast of America. The Pilsen, Joel, and General Electric Light Company has been formed with a capital of £200,000; as also have the Railway and Electric Appliances Company, capital £500,000, and the Electric Carbon Storage and Apparatus Manufacturing Company, capital £150,000. The daily papers have recorded in varied language this sudden flood of companies, but the majority of them stigmatise it as a "mania," and prophesy that some one will be "bitten." The *Daily News* of the 18th inst. says:—"Opinions differ of course, some being that the general inevitable collapse has begun; others that, this being an opportunity for the public to come in, the bears will be caught, and a great reaction will ensue." It does not appear either that we have yet come to the end of this formation of new companies, as we have heard of more than one concern which it is intended to float in the immediate future.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 396, Strand, London, W.C.

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MR. STROH ON SONOROUS VIBRATIONS AND MAGNETISM.

We last week completed our account of Mr. Stroh's lecture, and before these lines are in the readers' hands its re-delivery will have taken place to a largely augmented audience. The interest which the subject of Mr. Stroh's experimental researches had already awakened insured an unusual attendance on the first occasion of their publication three weeks ago, but we have little doubt the council of the Society of Telegraph Engineers will have been justified in their prediction that a larger and more influential attendance would welcome Mr. Stroh's re-appearance. A rehearing was the more needful because, as we stated in our account of the original proceedings, nothing short of personal witness of the experiments would insure full justice being done to them. We are only repeating what was frankly admitted at the time that Mr. Stroh proved himself not only the careful experimenter and wonderful mechanician which we all knew him to be, but the possessor also of that rare gift of making oneself thoroughly well understood. As one well-known professor remarked it was not Mr. Stroh's business to lecture, but his performance that evening made all professional lecturers envy him. If he is as successful both in manner and matter as he was on the first occasion, Mr. Stroh's fresh audience will by this time be congratulating themselves on having had an altogether exceptional treat in the way of scientific exposition.

From one point of view Mr. Stroh's revelations were not, perhaps, of immediate consequence, but from another point of view their prospective importance can hardly be exaggerated. No thoughtful person could fail to see that a new means of investigating the phenomena of magnetism was now available, nor avoid speculating on the momentous disclosures which then for the first time seemed near at hand. That magnetic forces act in the same manner and in the same lines as do the forces set up by vibration is a fact not of striking moment, except as a new example of the uniformity of natural laws; but when it is realised that we have now for the first time discovered a way of not merely identifying, but of tracing those laws to their very source, so to speak, Mr. Stroh's experiments become extremely significant. For centuries we have "known" the magnet; only lately have we found out what it would do for us; and now at length we seem to be on the eve of learning the *how.* Until we listened to Mr. Stroh we had given the magnet up as an inexplicable mystery —a something to be used but not to be explained. The most learned exponent of the properties of magnetism was brought to pause if a simple schoolboy asked him, How comes it so? The schoolboy cannot be answered even yet, but one feels that the answer is not nearly so far away as it was but a few short weeks ago.

Mr. Stroh's experiments originated with those of Dr. Bjerkness, which were exhibited at Paris last year. Interesting as were those singular examples of attraction and repulsion in the case of vibrating drums under water, probably very few who witnessed them thought of them as anything but a curious parody of magnetic phenomena. Mr. Stroh appears to have taken a more serious view of them, and he determined to satisfy himself whether the seeming resemblance was real. This, of course, is not proven—perhaps is not capable of proof—but their identity of action he has demonstrated in every detail. Even where the operation seemed to be inverse to that of magnetism—as in the case of diaphragms vibrating in like and unlike phases—the seeming contradiction proved to be only verbal, attraction and repulsion actually occurring just as we know they do occur in the case of similar or dissimilar magnetic poles. But this is not all. We knew that vibration, even that impalpable vibration which gives voice to the telephone, indicates motion which imparts itself mechanically to the surrounding air; we knew also that light bodies assumed geometrical patterns when placed on a vibrating plate; what we did not know was that these air movements, these strange figures, corresponded exactly with the lines of magnetic force, and when diagramatically represented were the same as the old familiar pictures of the magnetic "field." The force is mechanical in the one case, and is what we must continue to call magnetic in the other, light bodies of any material being attracted or repelled when the force is vibratory, and only certain metals when it is magnetic; but the *habit,* if we may use the expression, is the same in both, and both pursue the same methods. The question then arises, Are not the forces the same? It is an important question, but whether answered in the affirmative or not—that is to say, whether or not the action of magnetism prove to be a species of vibration—the fact that vibration is a species of magnetism cannot fail to be a valuable help towards finding out what magnetism itself really is.

For the moment all interest is centred on the relation of sonorous vibrations to magnetism; but it is safe to conjecture that the investigation which Mr. Stroh's experiments have, doubtless, given rise to in many quarters will not stop at this. Not less mysterious than magnetism is the phenomenon of electricity, and thoughts fixed on the cognate properties of the magnet are pretty sure to be speedily turned to the phenomena of electro-magnetism. It would not surprise us if Mr. Stroh has already been tempted into this line of investigation. We would not presume to anticipate anything he may have to disclose on the subject,

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for we are sure that nobody in this country is better able than himself to examine it as it deserves to be examined. Our meaning will be obvious to every electrician. There is a magnetic field about every electric current, and, therefore, about every conducting wire. What we should like to know is whether this electro-magnetic field, in the case of a conducting wire, can be imitated in the case of a vibrating wire. It is certain that the attraction, and, possibly, the repulsion, of light bodies can be obtained even by the vibration of a fiddle string; but the identity of direction as compared with the known direction of magnetic force surrounding an electric conducting wire is still uncertain. The lecturer of last Thursday evening is just the man to determine this point for electrical science once and for all. Delicate and tedious as would obviously be the experiments necessary to establish the identity here suggested, the results would be well worth the pains. To solve the mystery of magnetism would be a remarkable feat, but to contribute something towards the solution of, if possible, the still greater mystery of electricity and its mode of travelling would be a feat worthy even of Mr. Stroh, and that, indeed, is saying a great deal.

SPECULATION.

We have no wish to decry the Englishman's privilege to grumble, but rather to act the part ourselves. It may be that promoters will not like our grumbling. That, however, is of no great matter, especially if, on the other hand, words of caution may induce some people, who have money but no brains, to save their money from the harpies, who have brains, and would like to have money. The existing state of things with regard to electric light companies is deplorable. Company after company is promoted and floated with a huge capital when it is absolutely certain that for years to come there will not be legitimate business enough to pay any per centage on a large part of the capital subscribed. These companies are, for the most part, intended to supply the electric light, and, startling though it may be, let us say once for all that there is no single company existing, so far as we are aware, that has yet made a dividend from its electric lighting work. This speculative gambling is a curse to true enterprise. Rotten companies, not worth the paper their prospectuses are printed on, are always started when the public lose their heads, as they seem to have done now, to the loss of the ultimate holders of shares. Companies may be and are brought out legitimately, and are worked by honest men. Unfortunately the public will not discriminate, and instead of taking counsel of their natural advisers, the scientific press, in such matters as electric lighting, prefer the probability of "heads" turning up in the gamble.

We are glad to see that for once the political press is speaking somewhat plainly, although in some of the money articles, so great is the "trimming" that what is intended as a caution to those who can read between the lines is openly advertised as an incentive to investors. The *Pall Mall Gazette*, in its City Notes of Tuesday last, had among other paragraphs the following, which is worthy of close attention :—" As the speculation has now reached a height so prodigious that the shares of one company alone—the Anglo-American Brush Light Company, of the original value of £400,000, including £100,000 in fully paid up shares paid as part of the purchase-money to the Anglo-American Electric Light Company—are now worth in the market more than £1,500,000, a few facts regarding the development of the gamble will be interesting, and possibly useful, to outsiders apt to be drawn in by the sight of the apparent gains now being pocketed. Including the South African Company, issued on Saturday with a modest capital of £100,000, the Brush Light Company or its offshoots has created nine subsidiary companies, to which it has sold the "rights" attached to its patents in the provinces or in various places abroad. Or rather the Brush Light Company has first sold concessions to individuals, and these in turn have formed new companies in a manner that has been highly profitable to all concerned—except, possibly, the ultimate finders of the cash. We have examined their prospectuses for particulars regarding the prices paid by the shareholders to the 'vendors' of these tributory companies, and have noted also where possible the cash said to have been paid by these vendors to the parent company for their concessions. As a rule, the latter fact is not stated, but without that the result is very instructive. Altogether, £205,000 in cash and £178,000 in shares have in this way been paid by these companies to the vendors, in the manner exhibited by the following table:—

Name of Company.	Capital issued.	Cash Paid to Vendor.	Amount in shares to Vendor.	Portion of Cash to Brush Co.
Electric Light and Power Company of Scotland (Brush)........................	£150,000	£15,000	£40,000	not stated
South - Eastern Electric Light and Power (Brush)	100,000	12,750	2,000	£10,000
Midland Electric Light and Power (Brush)	125,000	25,750	18,000	
Provincial Electric Light and Power (Brush)	100,000	30,000		25,000
Australian Electric Light, Power, and Storage Company (Brush)	155,000	45,000	30,000*	not stated
South African Electric Light and Power (Brush)	100,000	25,000		
Eastern Electric..............		32,000	38,000	not stated
Hammond	125,000		35,000†	not stated
Great Western	125,000	19,500	15,000	£12,750

* 1,000 founders' shares in addition. † 20 founders' shares in addition.

This is exclusive of the Devon and Cornwall Company, which is an offshoot of the Great Western Company, and of whose capital of £100,000 £34,750 goes to vendors and patentholders."

THE INDUCTOPHONE.

Mr. Willoughby Smith, so well known to most of us as an able experimentalist, has been recently experimenting in a direction that promises to be very fruitful of interesting and valuable results. We hope in our next issue to illustrate Mr. Smith's apparatus. In the meantime we may say that, using a tuning fork as a make and break contact in circuit with a large flat disc of insulated wire, he finds that a telephone, or a Bell telephone without the coil, or a magnet, or a piece of iron, altogether unconnected with the circuit, will reproduce the musical sound of the tuning fork. By means of a diaphragm he has investigated the lines of force from the coil, and has obtained some interesting results. The sounds are reproduced if the receiving diaphragm is in another room, or if there are two rooms with their walls and air between. In fact, the lines of force seem to extend a long way. If the diaphragm is placed parallel to the lines of force no result is obtained; but, of course, this may be obviated by using a hollow cylindrical or polysided diaphragm with a suitable magnet. Mr. Smith has undoubtedly shown us how to investigate in a new direction which promises well. We ourselves have made a number of experiments in this direction, with very satisfactory results.

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THE CRYSTAL PALACE EXHIBITION.

The Swan Light.

Before entering upon the special subject of this paper we may call attention to the fact that almost without exception the various lecturers at the Palace on Wednesday evenings have dealt somewhat in prophecies. Not only is the electric light to be *the* light of the future, but electricity is to be the transmitter of power of the future. Mr. Edison is designing his central stations with a view to supply power as well as light, and he hopes by this means to get the greatest possible per centage of work out of his machinery. It will be seen that Mr. Bright in his lecture touched on the same subject as did Mr. Crompton. More than forty years ago attempts were made to utilise electricity as a transmitter of power as well as directly as a motor. In 1836, Mr. Davenport, then a blacksmith in Philadelphia, turned lathes by means of electricity. In 1838, Professor Jacobi used a battery to propel

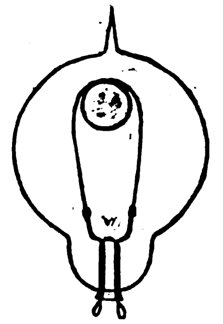

FIG. 1.—Swan's Lamp.

a boat on the Neva. In 1839, Mr. Robert Davidson used electricity to drive a carriage, and so on. We see, then, that the idea is in one shape by no means new. In a number of the *Practical Mechanic*, published in November, 1842, we read:—"So far as trials have been made, the hope is not excluded that this new agent may yet become a powerful rival to steam. In point of safety its superiority is unquestionable; but it remains to be determined whether or not sufficient power can be obtained on equally economical conditions. The machinery requisite will, from the nature of the power, be extremely simple in its construction, and moderate in cost, rotatory motion being directly obtained, and the methods of reversing, accelerating, retarding, and terminating the motion requiring no additions which can materially detract

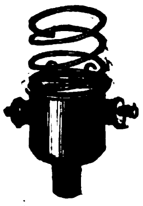

FIG. 2.—Connections for Lamp.

from the original power communicated." It was then pointed out that great improvements had been made in a short time in voltaic batteries, so that "the physiological, chemical, and mechanical effects which could be produced by batteries of a given quantity of surface, not above six years ago, can now be equalled by the action of batteries of a tenth part the size." "This," the author continued, "holds out very great encouragement to those who are engaged in the important task of applying electro-magnetism as a prime mover."

It is perhaps a little singular to notice that the connection of electricity with power and light has run somewhat side by side. The great development of the light during the past few years has directed attention to the connection with power, and we have already signs of immediate development in this direction. The success of the one seems to indicate the success of the other. At present the direction taken by inventors is the application of electricity for the transmission of power on railroads. The dynamo is to supersede the steam engine in front of the train, or to be applied to each carriage. This, however, may possibly prove a minor application, and the great advantages to be derived from such electrical transmission of power will be the providing every house with power that can be regulated and used when, where, and how desired—it may be to drive a sewing machine or to "rock the baby." The extended adoption of the electric light, then, seems to bring us face to face with the other problem also, viz., the distribution of power.

The success of Mr. Swan has brought the time of the general introduction of the electric light within a measureable distance. It is not for us now to discuss the comparative values of the Swan, Edison, and Maxim incandescent lamps; these can only be determined by extended trial. It must not be forgotten, however, that each of the three manufacturers has put a problem and attempted to solve it, and that this problem is not altogether the same, or the solutions would not be so difficult. Edison believes in a machine with low internal resistance, and a lamp with a high resistance. Mr. Swan, on the contrary, thinks the results obtained by this means not so satisfactory nor so economical as those obtained by the use of machines with a higher internal resistance and lamps of a lower resistance. Finality, however, has not been obtained by either inventor; for, if we mistake not, the lamps may and do receive modifications. The latest form of Swan lamp and its connections

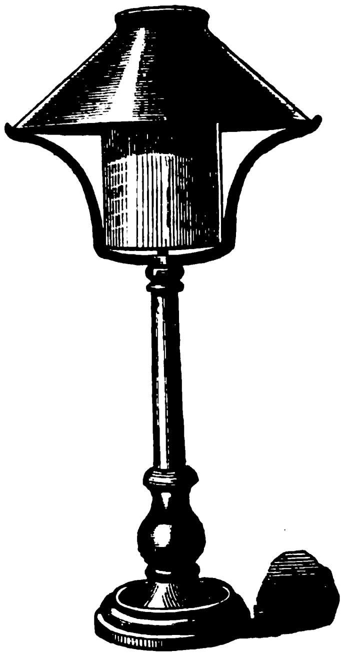

FIG. 3.—Table Lamp.

is extremely neat. Fig. 1 shows the lamp—in size a little more than two inches by three inches. At the top, through which the platinum connecting wires pass, is a glass plug. When the wires come outside this plug they are made into a little loop, as shown. The carbon filament, which is made of carbonised cotton, the cotton being first parchmentised by being acted on by dilute sulphuric acid, is made in the form of a loop, as shown. The reason of the loop shape is to obtain an equality of radiation in every direction, an equality not obtained by a simple loop, or the M shaped loop of Maxim. Fig. 2 shows the method of obtaining contact between the lamp and the line wire, and also the method of fixing the lamp. If the electric light is to supersede gas, there is no reason why existing gas fittings should not be utilised, and expense of replacement saved. Hence an ebonite or some other insulating base is taken and fashioned with a screw, as shown. This screw fits any ordinary gas pipe, as does the screw of a gas nipple. Two platinum hooks are connected through the base to the contact screws on either side, the line wires being brought to these contact screws. The loops of the lamp are hooked on to these hooks, and so far contact is complete. To ensure good contact whatever the position of the lamp, a

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small spring is used, which keeps the loops and hooks closely together, and, at the same time, gives a certain amount of rigidity and flexibility to the whole. The replacement of breakages is thus confined to the lamp itself. If one is broken another is hooked on to the contacts, and this can be done by any ordinary person who is capable of handling china or glass at all. Of course, there are already a number of elegant chandeliers designed for use with these lamps. We can, however, illustrate but a few of them. Fig. 3 shows a table lamp. Most of these stands are made

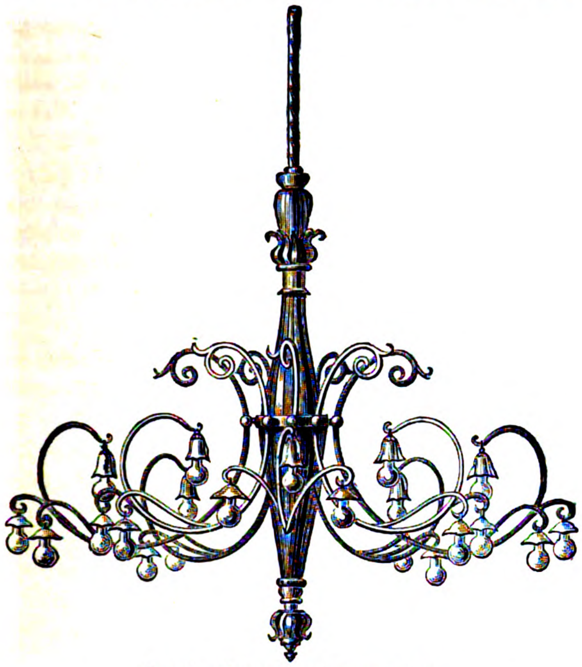

FIG. 4.—Chandelier for Swan Lamps.

with a plug, by means of which the current can be switched on or off, just as the tap of a gas pipe is turned on or off as required. One advantage possessed by the electric light is that no matches are required. The switch is turned and you have the light. There is no danger from an escape, and with ordinary common sense precautions there is no danger from fire. We may say that with any incandescent system there is absolutely no personal danger from contact with the

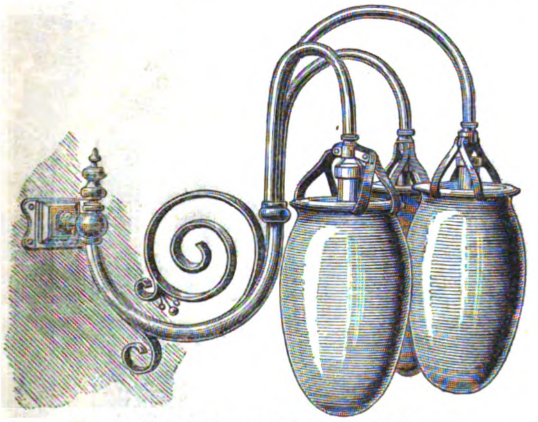

FIG. 5.—Swan's Lamp, as at the Savoy Theatre.

wires. Fig. 4 shows a hanging chandelier for a number of lights. Specimens of these lamp-holders may be seen at the Palace. Fig. 5 shows the arrangement adopted for clusters of three, as adopted at the Savoy Theatre, specimens also being shown at the Palace. Fig. 6 shows the large chandelier as exhibited in the furniture court. We believe there are 98 lamps on this chandelier. Messrs. Faraday and Sons have designed and constructed the chandeliers and fittings for the Swan lamps.

Mr. Swan has also given a great deal of attention to the manufacture of lamps for mining purposes. His latest form of lamp for this purpose is illustrated in Fig. 7. It will be seen that every care has been taken to avoid danger from accidental metallic contact, and that the lamp is, if not absolutely perfect, a long way in the right direction.

The current for the Swan lamps is obtained from Siemens's alternating current machines of the type known as $\frac{W_1}{D_7}$. It will only be necessary to mention anything peculiar in this installation, as these dynamos are well known. Take, then, the illustration in Fig. 8, where the dynamo, with a Gwynne fast-speed engine, is fixed on one frame. We believe this is the first installation in which such engines have been used. The number of revolutions is between 300 and 400 per minute. One dynamo supplies the current for 52 lamps in Messrs. Elkington's show room, for 133 lamps in the picture gallery, for twenty lamps in the office, and for one lamp at the machine—or a total of 206 lamps.

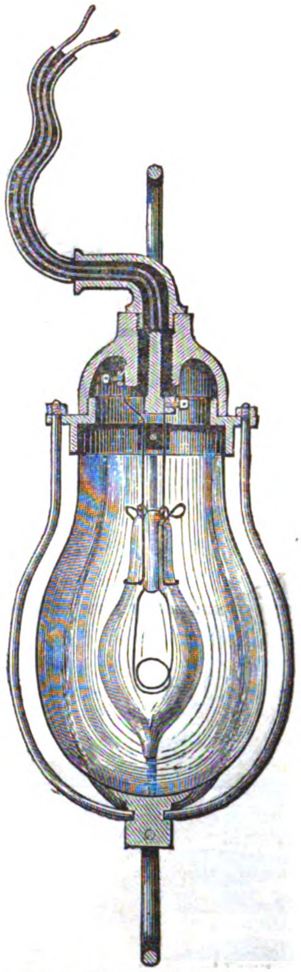

FIG. 7.—Swan's Miners' Lamp.

Each lamp under normal conditions gives a light of about 20 candles, and has a resistance, hot, of from 32 to 35 ohms. The lamps are all arranged in single multiple arc. Machine No. 2 supplies the current for the 98 lamps in the furniture court, for one lamp at the machine and two in the office, as well as for 40 and 30 lamps respectively in the dining rooms. These latter lamps, we believe, are exhibited by the Messrs. Siemens. The machine thus supplies a total of 171 lamps.

Since the opening of the Exhibition a third machine of the type SD_2 has been used to supply the current to about 40 lamps, some of which are in Messrs. Elkington's exhibit, others in a small furnished room adjoining the office, as well as the usual one at the machine. Although these constitute the exhibits of the Swan Company there are besides these a number of other exhibitors who use the Swan lamps. Among these we may mention Messrs. Elmore, Messrs. Hindley, Messrs. Patterson, and the Turner Gas Engine Company. Besides these the White House Mills Company are using some 130 lamps, and supplying the current with the Arago disc machine.

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The whole of the arrangements of the Swan Company exhibits have been carried out under the superintendence of Mr. J. F. Albright. It is hardly necessary for us to mention that, as the time of closing the Exhibition is rapidly approaching, those who have not hitherto seen it should endeavour to do so, as it is undoubtedly the best exhibition of electric lighting ever seen, and one that is not likely to be again witnessed.

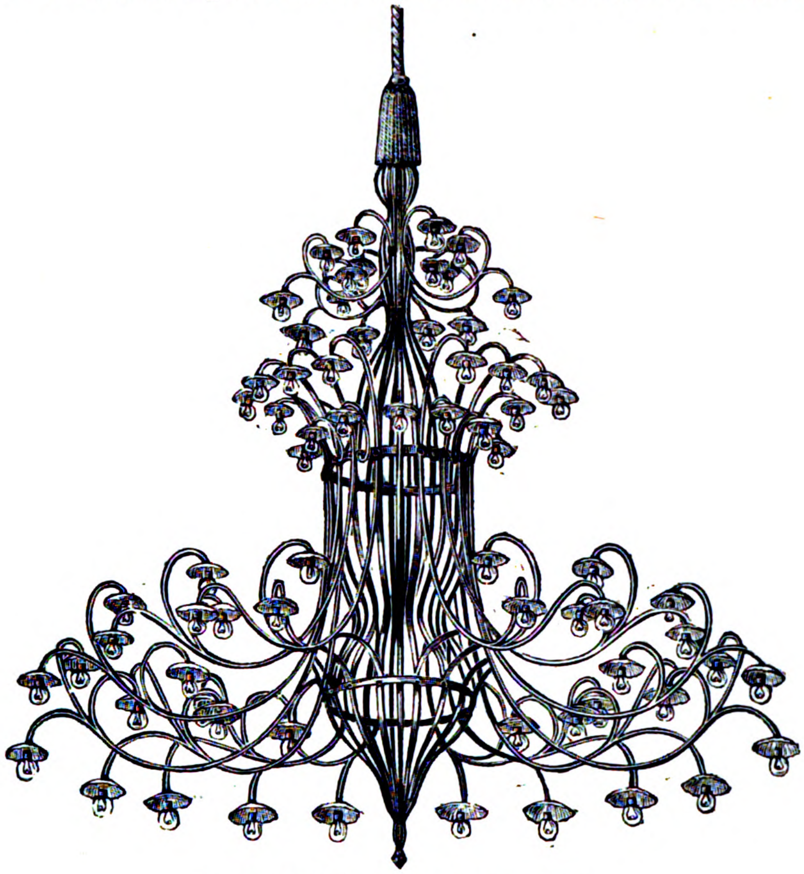

Fig. 6.—Chandelier shown in Furniture Court.

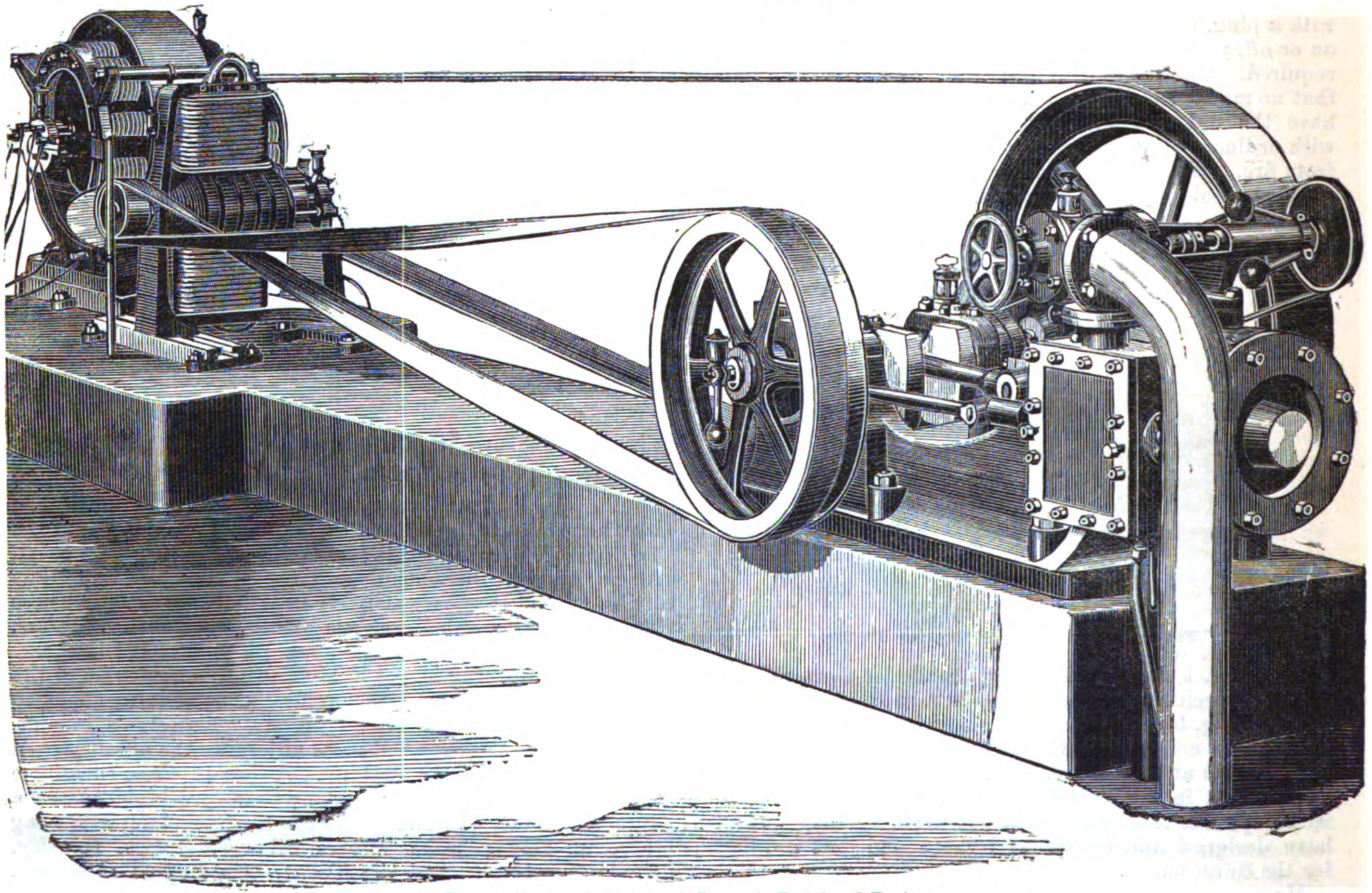

Fig. 8.—Siemens Dynamo and Gwynne's Fast-Speed Engine.

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THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

At this Society's meeting, held at the Institution of Civil Engineers, on 11th May, Professors AYRTON and PERRY communicated a paper describing various instruments devised by them for measurements of electric lighting. Professor Ayrton, who acted as spokesman, remarked that, after the highly interesting lecture delivered on the occasion of their last meeting, what he had to say to the members that night would appear tame and dry; but in view of the great progress of electric lighting enterprise, some account of attempts made by Professor Perry and himself in supplying one of its greatest requirements—namely, the means of obtaining exact measurements, would probably prove acceptable. Repeating some portion of his remarks when describing their ammeter last year, Professor Ayrton said that one chief hindrance to exact measurement with ordinary forms of galvanometers was that the deflection never proportionately followed the current, nor had there been any easy method of calibrating the apparatus. Their first attempt at overcoming this difficulty was by altering the position of the needle, or, what amounted to the same thing, by tilting the coil in such a way that the magnetic moment of the coil increased with the deflection. To some extent this was successful; but still the deflection was not proportionate all along the scale. But afterwards it was found that, by altering the shape of the needle and altering the shape of the coil, an instrument could be devised which would rigorously answer to the varying strength of current passing through. Such was the ammeter, and this little apparatus would measure very accurately the arc currents, which ranged from 15 to 60 ampères on the one hand, or incandescent currents measuring as little as 2 ampères on the other. A voltmeter had been constructed on similar principles, but whilst this instrument was used in series, the ammeter was used in parallel. With these two appliances, and taking their respective readings, any part of an electric light circuit, of whatever kind it might be, could be tested so as to indicate the horse-power being absorbed. Their sensibility could be instantaneously halved by the insertion of a plug. A third instrument had been devised so as to give the result at one reading—a thick wire being used for the main current and a thin for the shunt. This instrument had been described by Sir W. Thomson at last year's British Association; and it gave the rate of doing work, or the amount of electric power being expended.

The next class of measuring instrument was one which dispensed altogether with permanent magnets, and which, therefore, had some obvious advantage to start with. It consisted of a coil with long iron needle enclosed, to the upper end of which was affixed an aluminium pinion and pointer. The needle had but very small range, or rather its deflection was very feeble, and its reading, therefore, practically true. To render the movement visually plain, the pointer and pinion came into play, and multiplied the deflection, so that a wide range of reading was obtained. As there was no initial magnetism, the needle was independent of the flow of the current, and the instrument could, therefore, be employed for either direct or reverse currents. Here the sensibility was increased or diminished by the use of springs, which could be adapted to the probable strength of the current to be tested.

For measuring the resistance of any part of the circuit another form of instrument had been contrived. In this two coils were placed at right angles to each other, the one of thick wire, the other of thin, with a needle in their midst. On joining the thick coil to the main circuit, the needle would assume a decided position. The thin wire coil was then connected in that portion of the circuit required to be tested, and the resulting deviation of the needle would indicate the ratio of the shunt circuit to the main circuit.

In order to measure large currents, ranging from 400 to 500 volts, without interfering with the lights, recourse had been had to a form of electrometer, similar to the well-known form devised by Sir W. Thomson, the pairs of quadrants and the aluminium needle being joined, as in his experiments, to the circuits being measured. The electrometer would, no doubt, play an important part in measuring electric light circuits when reverse currents were being employed, as, owing to the different inductive capacity of their coils, some of the instruments previously described were not trustworthy in respect to the measurement of such currents.

Professor Ayrton then described what might be styled a coulomb meter, that is to say, a device for measuring and recording the actual amount of current that had passed through the circuit during a lengthened period. An arrangement of vanes connected with a galvanometer of special form recorded by their revolutions the total current that had flowed through them. Mr. Edison, however, had, it now appeared, recently patented a similar arrangement, so that he might be said to have been beforehand with Professor Perry and the lecturer in this contrivance.

A simple form of photometer was then explained; but this has already been made public. The chief point of interest remarked upon by the lecturer in this relation was the fact that near observations always gave the highest readings, explainable only on the supposition that in the distant observations some of the green rays became absorbed and lost, especially when the condition of the atmosphere favoured their absorption.

Mr. OBACH then described several measuring instruments employed by Messrs. Siemens in their work of electric lighting, one a dynamometer connected with the two arms of the driving belt; another for measuring current strength by a species of torsion galvanometer, the coil being suspended; and the third a movable ring galvanometer, on the tangent principle.

As the evening was now too far advanced to admit of Professor Ayrton's second paper on Technical Education being read, a brief discussion ensued, in the course of which Mr. C. VERNON BOYS remarked that he had last year suggested the use of a non-magnetic needle for this kind of measurement; he also thought that the rolling contacts in the coulomb meter would be subject to faults which might seriously affect the resistance, and therefore the exactitude of the measurement—and this notwithstanding the assurance of Professor Ayrton that the meter, being in a shunt circuit, the results would not be affected. —Mr. GORDON testified to the dead beat character of the instruments described.—Professor FLEEMING JENKIN complimented the Society, from attending whose meetings he had been prevented for some years past, on the great strides it had evidently made in the interval.—Professor ADAMS also spoke in high terms of the ingenuity and comprehensiveness of the apparatus exhibited.—The usual votes of thanks to Professors Ayrton and Perry, and to Mr. Obach concluded the proceedings.

THE PROGRESS OF ELECTRIC LIGHTING.

At a meeting of the Royal Institute of British Architects, held on Monday last, at No. 9, Conduit-street, Regent-street, Mr. J. Slater, B.A., read a paper entitled "The Recent Progress in the Electric Lighting of Buildings," but the paper in reality covered a much wider field.

The room was illuminated by several forms of the electric light, the motive power being supplied by one of the new batteries of Messrs. Sellon and Volckmar. The Swan, the Lane-Fox, the arc, and other lamps were exhibited, the entire apparatus working admirably throughout the evening.

Mr. SLATER then read his paper, in the course of which he referred to the revolution which the last three years had effected in the opinions of scientific men as to the sphere of usefulness of the electric light. The author observed that this revolution was mainly due to the invention of incandescent lighting, which might be defined to be the unlimited power of concentrating large quantities of heat into small foci without consuming the heated body, which thus became a stable and unchanging point of light, in contra-distinction to the arc lights, in which the glowing material was continually disintegrating and burning away. The incandescent systems of electric lighting were based on the fact that, if preserved from combustion, carbon is practically infusible, and the chief difficulties in the way of making incandescent lamps lay in the fact that it was necessary to enclose in an exhausted glass globe an extremely thin filament of carbon, which must be in electrical contact with the wires outside the globe, and which must be able to stand an enormously high temperature. Messrs. Swan, Lane-Fox, Edison, and Maxim had overcome these difficulties in different ways. Incandescent lamps could be used with almost all kinds of dynamo machines, but they could also be worked with an invention which, as a practical means of supplying electricity, must be regarded as the outcome of the past year, but which would be epoch-making in the history of electric lighting, viz., the storage batteries, or accumulaters of electrical energy. The economic value of incandescent lighting was one of the most important points to be considered, and although at present the data upon which to found an opinion were but scanty, the cases in which the details of cost had been most accurately worked out tended to show that the economic value of the new means of illumination had been, if anything, under-rated. The readiness with which the incandescent lights lent themselves to any scheme of decoration was one of their chief attractions. There was no necessity for following on the lines of gas fittings, as the conditions were so completely altered, but points of light could be placed wherever they were required,

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and there was no fear of blackening ceilings and decorations or of setting fire to the most easily-ignited materials. The progress of this system of lighting had been so rapid that architects had as yet had no time to turn their attention to its decorative capabilities, but when they did so they would find it fulfil every requirement for perfect lighting. Mr. Slater then alluded to the arc light systems, in which less progress had been made during the past year, but the sphere of usefulness of these systems had become more clearly defined, and the Mansion House was a good example of their adaptation to rooms of an exceptionally large size. If these large lights could be concealed and their rays reflected downwards from a large screen or a white ceiling a very pleasant and diffused light would be obtained, and the slight irregularities, due for the most part to the carbons, would be much less perceptible. Simplicity of construction was the great thing to be aimed at in these lamps, and the Weston arc lamp was a good example of their newest form, and this might be termed a strictly electrical lamp, as contrasted with a mechanical one. The great difficulty with which these arc lamps had to contend was in the nature of the carbons, in the manufacture of which but little improvement had taken place. The social aspects of this question were very important. These concerned the distribution and measurement of the electricity, the conditions necessary for reconciling the rights of the consumer and of the purveyor, and the risks to be guarded against. For electricity to compete with gas as a general means of illumination, it must offer as many facilities as its rival; and the Edison installation in Holborn, and that of the Swan lamps at the Savoy Theatre, showed practically that this condition was complied with. After describing these installations, the author explained the various methods of laying the mains, connecting the branches and arranging the lamps so that all were perfectly independent of each other, and showed how the strength of the current in the mains was cleverly regulated in proportion to the amount of work that it had to do. Perfect insulation throughout was the great desideratum, and if this point were always carefully kept in view, the dangers of electric lighting would be reduced to a minimum. Considerable attention had been given to this matter in America, and the Board of Fire Underwriters of New York had framed a code of regulations bearing on the subject. The Crystal Palace Exhibition was an exceptional case, as the installations were temporary, and the risks such as could not possibly occur in a well-devised permanent arrangement. Mr. Slater finally referred to the importance of the subject to architects, and recommended members of the profession to make physical science a subject of study.

The President of the Institute, Mr. Horace Jones, who occupied the chair, then invited discussion, first calling upon

Mr. Swan, who began by describing the paper in its entirety as the most complete and the most lucid lecture on electric lighting that had, in his opinion, ever been delivered [cheers]. He could confirm the statement of the lecturer that there was an essential economy in electric lighting, more particularly by the incandescent system—the form of electric lighting which he believed had the widest application and the greatest interest for the public. The comparison must be instituted between gas and electric lighting, for gas was really the light with which electric lighting would have to compete. If we made a comparison between the cost of producing a certain light by means of gas and by means of electricity we arrived by a simple process at something like this result:—2cwt. of coal, carbonised in a gas retort, turned into 1,000 cubic feet of gas, which would give a result of somewhere about 3,000 candle light for an hour burned under ordinary conditions in ordinary burners, in other words something like 5ft. of gas. This was giving gas the most advantageous conditions for its burning. If this same quantity of coal were employed to generate motive power through the medium of a steam engine, especially if it were supplied in the most economical form through some very large and well-appointed establishment where there was no waste of fuel, we could obtain for this quantity of coal 100 horse-power for an hour. This was a moderate estimate amply confirmed by a great number of instances, and the 100 horse-power which the 2cwt. of coal would give would be capable of producing through the medium of incandescent lamps 20,000 candle light. It was necessary to take into account with the generation of gas that gas was not the only product yielded by the carbonisation of coal. There were other products of almost equal value. The gross cost of 2s. 9d. in producing 1,000 cubic feet of gas was reduced to the extent of 1s. by the sale of the secondary products. With even so liberal an allowance as this, still we had a large advantage over gas in electric lamps. If we assumed the products to be sold to buy other 2cwt. of coal, of course we could get another 1,000 cubic feet, which would give 3,000 candles, thus raising the quantity to double, viz., 6,000 candles, but still we had the difference between six and 20 in favour of the electric light. An economy of this nature was only obtainable on condition that the motive power was produced in the most economical manner—as, for example, in large electric lighting establishments, from which he hoped facilities would be given in connection with the proposed legislation now before Parliament. Facilities for the investment of capital for the creation of large electric lighting stations should be given, or otherwise the public would be deprived of the benefit of a perfectly innocuous illuminating agent, such as this was. There was more danger of this than of the whole thing becoming a monopoly. He augured well from the fact that the assistance of architects was now to be given to electricians in bringing about a change in the matter of domestic illumination. The hands of electricians were so full in dealing with the physical aspects of the subject that the mere decorative section of the work might safely be left to architects.

Mr. Lane-Fox said the danger apprehended from the use of the electric light was a mere myth. He believed it to be a monster conjured up in the brain of the gas vendor and the insurance broker, who naturally enough wished to make the most of it [laughter]. There had, no doubt, been certain unpleasant results from the improper application of electricity. One or two people had been killed, and a few places had been set on fire by electricity [a laugh], but similar results would accrue from the improper application of fire or almost any other agent. If we set light to a fire in the middle of our room we could not expect it to go on burning without doing damage, and so with electricity. Treat the agent improperly and there was sure to be danger. The dangers could be divided into two heads—those which resulted from physiological effects, such as shocks, and those which produced fire. Electric shock was due solely to high tension in the electricity. The electricity must be driven to a very high tension before any appreciable effect was produced. When applied to public lighting, as it undoubtedly would be, it would be impossible to produce any physiological effect. The lighting of this room was produced by electricity at a tension of some 60 units of electrical pressure, and he would not mind holding the wires, and guarantee not only the absence of shock, but the absence of any feeling at all.

Electricity would be supplied at a low tension, and then would not be at all dangerous. It was, in fact, infinitely more practical and convenient to supply it at a low tension, its subdivision being easier, and its economy beyond question. Many persons fancied that by taking hold of dynamo machines, and particularly the Brush machine, that they were sure to be struck dead! When it was necessary to drive the current a great distance and to have a great length of wire, it was highly desirable that the electric current should be capable of overcoming resistance, and the only way in which it could be made to do that was to drive it at a very high tension, for when applied at a low tension it was in a very much lower quantity. As to the second danger, that from fire, it only arose from careless manipulation. He believed that in the earliest days of gas the leakage was about 50 per cent. of the total product. After a time they managed to reduce it by 30, and now he believed it was no more than 3 per cent. With electricity he thought they could make a fair start with insulation on a much higher scale than the best insulation of gas, because their knowledge of the subject, thanks to telegraphy, &c., was much more perfect. The whole subject had been thoroughly thrashed out, and there was very little doubt in the minds of those who understood it. Many people having very little experience in the matter their ideas of insulation were certainly crude, and hence dangers had arisen. After a few remarks on the subject of storage batteries, which had been very much misunderstood, Mr. Lane-Fox concluded by saying that this was, perhaps, too purely technical a matter to enter into fully just now.

Mr. Fowler asked Mr. Slater whether it was possible to order a supply of electricity for a required number of rooms, just as you ordered a supper for a given number of guests at so much per head [laughter].

The President said that in the course of his paper Mr. Slater had referred to the first essay in electric lighting made at the Mansion House. He had the honour of attending the banquet on that occasion, and they had scarcely finished supper when they were in total darkness [laughter]. As to the remarks of Mr. Swan touching the comparative cost of gas and electric lighting, he would not be prepared to give that gentleman the verdict entirely in his favour without hearing the gas companies on the other side. He had to make enquiries a little while ago of a very well-known man, and was distinctly informed that to light a very large area some economy would be found upon the side of electricity, but he intimated that to obtain this economy he should be compelled to use the arc light, and not the incandescent, and that he considered the difference as four to one in favour of the arc light as compared with the incandescent. He was quite sure the Institute would not separate without passing in the most

cordial manner a vote of thanks to Mr. Slater for his admirable paper.

Mr. Blomfield said that in common with the other members of the Institute he had listened with the utmost interest to the paper, and they owed Mr. Slater a real debt of gratitude. The hint he had given as to the necessity of young architects paying some attention to physical science was of great importance. If, as no doubt would be the case, electricity were to be the light of the future, all architects must make it their business to understand how that light was produced, and how it could best be adapted to buildings. Certainly they would not require to be too much wedded to the old associations of gas and candle lighting. It was quite clear that electricity could be applied in ways which were entirely new without any danger of injury to the building, or from blacks, or anything of that sort. He had great pleasure in proposing a cordial vote of thanks to Mr. Slater.

Mr. Hayward said he seconded the motion, first, because of the pleasure the paper had given him, and secondly to supplant some remarks it contained relative to the electric lighting experiment which had been carried on at Godalming. He knew some of its successes, and some of its difficulties. The origin of the idea at Godalming was this :—A quantity of waste water was continually running from a certain mill, and it occurred to the millers that this could be turned to advantage to light their own factory, and at the same time light the town. They had a certain number of water wheels that they did not always use, and as we all knew the river Wey passed through the town. There came certain floods in the river, as often happened directly after the electric lighting was carried out, and there was considerable failure, and it was well to understand the failures of the system as well as its successes [hear, hear]. For several weeks the incandescent lights, to which he looked with great promise, gave no light at all, and everybody in the neighbourhood was calling out against them, whilst there was great fear and great anxiety on the part of those who were interested in the subject lest the town should go back to gas lighting. This was very likely, for many of those who were the most in favour of electricity were for giving it up entirely. He believed at that moment Messrs. Siemens stepped in rather than that the whole subject of electricity should be put aside by such an experiment failing, and he believed they had established a steam engine, and had given up the lighting of the town by water, not that the water itself failed, but simply from the circumstance that there was not sufficient power in those water wheels to do what they were required to do, and occasionally there were floods, and there was the want of an accumulator to act as a gasometer. The success of working by water would have otherwise been accomplished. As it was, it was simply put aside for a time, and the present success he might now say was considerable. It was very satisfactory to him, as one living in the neighbourhood, to find that the experiment, though it did not succeed at first, was not allowed to throw a slur upon electric lighting, but that it was able to be continued, and that when Mr. Slater went down to look at it he was able to return with the favourable report he had made in his paper that evening. If they would only carry the wire as far as his house he would use it himself.

The motion was carried unanimously.

Mr. Slater said that under ordinary circumstances anyone who ventured on two successive occasions within little more than a year to read a paper here on the same subject might, he thought, not unjustly be accused of presumption. But the progress of the electric light had been so rapid, the novelties in its use had been so striking, and the general interest taken in the subject was so exceptional, that electric lighting stood almost in a category of its own. Hence, although he felt considerable diffidence in acceding to the request of the Council to give another paper, he hoped at the end he might be able to interest his hearers. But he felt that little thanks were due to him. If it had not been for the kindness of the gentlemen who had assisted him in showing the lights exhibited in the room, he would have had a very hard task, and his endeavours would have fallen very flat. In fact, he would have been very much in the position of the theatrical manager who, having announced the play of *Hamlet*, with a full cast, found himself on the evening of the performance obliged to read it himself, because all his performers were not in a state to exhibit themselves [laughter]. His thanks were particularly due to Messrs. Sellon and Volckmar, who not only in the kindest way placed one of their new batteries at his disposal, but had been at a great deal of trouble in fitting up the wires. He thought that the Institute owed a great debt of gratitude to them for showing what could be done by means of incandescent lights. With regard to Mr. Fowler's question as to whether you could send to Mr. Volckmar's for a supply of electricity as you could send to a *restaurateur* for a dinner, no doubt Mr. Volckmar could do it. With regard to the arc light being economical, there was no doubt that it was so. But it must be borne in mind that, although you got a greater amount of light, yet in the immediate neighbourhood of the arc itself you got a great deal more light than was wanted, so that it might be more economical to use several small lights rather than one large one, although the amount of light obtained might be less. As to Godalming, Mr. Hayward had given precisely the facts. They tried water power, but found they could not get on, until Messrs. Siemens Brothers took up the work with good results. With regard to another question—as to some lamps burning clearer than others—this was due to the variation in the resistance not being equal. If the resistance of the filaments were precisely the same the current would work them to precisely the same amount of brilliance. With regard to water power, it could be used effectively, because Sir William Armstrong (at Newcastle) illuminated his picture gallery by a turbine driven by a waterfall in his own grounds ; but you must get a certain fall to do it. In conclusion, he thanked the meeting for the kind way in which they had received his paper.

On the suggestion of the President, a vote of thanks was also passed to Messrs. Sellon and Volckmar for their important contribution to the interest of the evening.

The proceedings then terminated.

INSURANCE COMPANIES AND ELECTRIC LIGHTIN G

The second lecture of this course was given at King's College, on the 10th inst., by the evening lecturer in physics, Mr. R. E. Day. The lecturer commenced by describing the various ways in which the strength of an electric current can be measured, and illustrated these several ways by showing the action of galvanometers and electro-dynamometers of various kinds. For many years considerable confusion has existed on account of the want of some common system of nomenclature for the different electrical quantities, and one of the great benefits of the recent electrical exhibition at Paris was that at a congress of electricians which was held there, certain definite agreements were come to as to the units of electrical measurement which should be adopted for the future. It was then decided that the unit of current should be called an ampère, the name being derived from that of a celebrated electrician who lived in Paris in the first half of this century. The lecturer then went on to say that whenever electricity comes into general use as an illuminant it will be absolutely necessary that each consumer should have an electric current meter, so that both he and the company which supplies the electricity may know exactly how much he uses, and also that he may not have to pay for more than he has actually used. The new Edison electric light meter, which was lent for the occasion by the kindness of Mr. Francis Jehl, of Menlo Park, was then exhibited, and the principle of its action explained. If an electric current, no matter how it is generated, be made to pass through a compound liquid it generally decomposes it, and the products of the decomposition gather at those places where the current enters and leaves the liquid. Now, it was proved by Faraday that the same quantity of electricity, that is, an electric current of a given strength, decomposes chemically equivalent quantities of all the bodies which it traverses. For instance, in the decomposition of water it will be found that for every 18 parts of water decomposed, two parts will be hydrogen and 16 oxygen; in order to form water from its two component gases we must take them in this ratio. It follows from this law that the quantity of the substance which is decomposed is proportional to the total quantity of electricity which passed through it, and is independent of the time during which the electricity passed ; and the quantity corresponding to the passage of one unit is called the electro-chemical equivalent of the substance. Thus, when one unit of electricity passes through a solution of sulphate of zinc having zinc electrodes, the action is as follows :—For one unit of electricity, one electro chemical equivalent of zinc would appear at the cathode, one electro-chemical equivalent of oxygen at the anode, and unite there with the zinc and sulphuric acid to form another electro-chemical equivalent of sulphate of zinc, and take the place of the one just decomposed. This action continues and keeps on depositing zinc on the cathode, and taking zinc off the anode. This is the principle of action of Mr. Jehl's current meter, and no matter how much current passes through it, for every electrical unit or fraction there will be a corresponding number of units or fractions of a unit of the metal deposited. The meter itself consits of two bottles, each containing two plates of zinc in a solution of zinc sulphate, and the current in passing causes one plate to increase in weight at the expense of the other. As, however, if the whole current passed through the bottle this change would go on too rapidly, a properly proportioned shunt wire allows just 1-870th of the electricity going to the house main to pass through the meter. The estimate of the quantity consumed is made once a month by weighing the plate that has received the deposition.

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The second bottle is a check cell, and the party that has access to the one has not access to the other. The second or check cell is taken out once a quarter and the deposit weighed. In the bottom of the case containing the cells there is a very ingenious arrangement of shunts, and also a very ingenious thermo-electric arrangement, which Mr. Edison has devised in order to prevent the freezing of the sulphate of zinc solution in winter. The latter part of the lecture was devoted to the principles of action of dynamo machines.

ELECTRIC CONDUCTION AND DISCHARGE.

BY F. E. UPTON.

The question of the nature and the vehicle of the electrical discharge is an important one, and its determination will contribute greatly to the solution of many interesting problems in cosmical physics. It is desired in this article to call attention to some recent advances that have been made in that direction.

The view that the phenomenon is one of pure conduction, though it has received the attention of eminent physicists, can be said to be no longer entertained.

When a conductor is made to connect two poles or electrodes which are at a different potential, it is well known that the greater the cross section of the conductor, or, in other words, the more of the conducting material is laid bare by a cross section, the *less* resistance will be offered to the union of the electricities of the two terminals, and the greater will be the ensuing current, with a given E.M.F.

Now, in the discharge, the contrary is observed directly. This characteristic of conduction is absent when the discharge takes place; in a tube containing air, the greater the pressure (above a certain inferior limit), or the more of the conducting material there is laid bare by a cross section, the *greater* will be the resistance to the passage of the spark, and the nearer together the terminals will have to be brought to effect a spark, with a given difference of potential. Sir Wm. Snow Harris, in 1834, made an attempt to grasp at the law governing the relation of the length of spark to pressure; and he then stated that the length of spark is in the simple inverse ratio of the pressure. Gordon, in 1878, made a series of experiments to test this law ("Elec. and Mag." II. 55-62). He found that from a pressure of about eleven inches to that of the atmosphere Harris's law held approximately good.

Representing resistance by r, and matter laid bare by cross section by s, in the case of conductor $r = \frac{1}{s}$; in the case of discharge 92 of $r = s$, approximately. Thus there is in question two entirely different order of phenomena.

Another distinctive characteristic of conduction will be recognised in the fact that whenever there is any conductor at all, however small and however long it may be, connecting two poles, some degree of current will flow, as long as there is any difference of potential. With discharge, however, a certain lower limit of distance apart of poles, and of interposed matter, is requisite for any current at all, and when that limit is reached the spark passes, instantaneously, and the discharge commences.

Whether the current passes by conduction or discharge heat is equally developed; in the conductor in the one case, and in the interposed matter in the other. This common development of heat does not in any way assimilate the two phenomena. The condition of affairs in the two cases will perhaps become obvious if recourse is had to the corresponds hydraulic analogy.

Imagine a pond of water held in place by a dam, with a pipe leading from the bottom of the dam for the purpose of drawing water from the pond. The smaller that pipe is in section, the smaller will be the current of water flowing through it under a given head, and a certain amount of heat will be developed by friction of the water against the interior of the pipe; moreover some degree of current will flow as long as the pipe has any size of cross section at all. That corresponds to conduction. Now let the pipe be imagined closed to the exit of water; as long as the dam is sufficient, no current at all will flow; but suppose the dam be diminished in thickness gradually and constantly, a point will be eventually reached when it will no longer suffice to hold back the water, which will break through the impediment; the friction of the water against the fragments of the dam, and of those fragments against each other, will develop heat as in the first case. That correspondends to the discharge.

By this analogy the difference between conduction and discharge is clearly apparent. A conductor between two points at a different potential never offers any *resistance* to the passage of the current, strictly speaking. Instead of saying that a slender wire offers more resistance than a thick one, it would give a better understanding of the matter to say of the latter that it offered a freer passage to the current than the former. In the case of discharge, on the contrary, the matter interposed between the points acts always as a bar, or resistance to be overcome, and the more there is of it the more resistance. It is never an aid or way.

Mr. E. Goldstein, in the *Annalen der Physik*, describes an ingenious experiment bearing upon this point, which, if not conclusive, is entitled to some consideration. In a discharge tube which was filled with dry nitrogen he placed a little sodium, which could be vaporised by heating. The positive light had a purplish red colour, but in the vicinity of the sodium it was of a golden yellow. By careful heating and manipulation the upper half of the tube could be kept red and the lower half yellow. Now the tube was brought over and near, in a horizontal and equatorial position, to a powerful magnet. The discharge light was repelled as a slender thread to the opposite (upper) side of the tube, but it was a pure reddish thread, and showed no trace of sodium yellow; so the sodium was not displaced or repelled under the influence of the magnet, as it would have been had it been a *conductor* of electricity.

There has been considered the possibility that metallic particles thrown off from the electrodes might be the conductors of the current. To determine if this were the case, Mr. Goldstein made use of a tube with platinum electrodes, in which the light from the cathode was deflected by a second cathode. The light alone underwent this deflection, while the minute particles torn off from the platinum, which lodged on the opposite wall of the tube and formed a sort of mirror there, went exactly to the same point after the deflection of the light, as before. There was thus no connection between the light of discharge and the abraded metallic particles.

But the most elegant demonstration in this matter has been furnished by the experiments of De La Rue and Müller; they arranged that the discharge of 2,400 chloride of silver cells should pass through a circuit consisting of a vacuum tube and a large variable resistance, R—; now with different resistances R_1, R_2, the resistance of the vacuum tube formed a varying fraction of the whole resistance; and, according to Ohm's law for the fall of potential along a conductor, the fall of potential along the vacuum tube should have been variable, had its function been that of a conductor. It was found in fact, however, that the fall of potential along the tube remained constant, no matter what resistance was introduced in the remaining part of the circuit between the poles of the battery, showing that the discharge was not a case of true conduction, but that even at the lowest pressure it was disruptive.—*Science.*

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).

The seventeenth ordinary general meeting of the above Company was held on the 12th inst., at the Cannon-street Hotel, under the presidency of Sir James Anderson, the vice-chairman of the Company.

The SECRETARY (Mr. Richard Collett) read the notice convening the meeting and the minutes of the last meeting, which were confirmed. The report of the directors, which has appeared in *The Electrician*, was taken as read.

The CHAIRMAN: I have a few remarks to make on the report, but before saying anything on that I must first apologise for the small number of directors present to-day. Lord Monck, who I dare say you know is Lord-Lieutenant of the county of Dublin, cannot leave his post, owing to the late lamentable event. Mr. Chaytor, one of our most esteemed, respected, and invaluable colleagues, I am sorry to say, is very ill, and Sir Thomas Fairbairn has been summoned to a committee of the House of Commons for two o'clock to-day. You must therefore take the few members of the Board, who are here as representing your interests. The only remark of any great moment is to tell you of the condition of our cable. When we last met you we had a fault in the shore end, and the fault was so minute that we were not quite certain whether it was in the shore end at Pernambuco, or in deep water. However, we sent a vessel out to remove the fault, and did so, and she found the cable seaward of her, towards St. Vincent, in as good condition as when it was laid, but the shore end, about eight miles inward from that point, we found we must renew. The cost of that will very likely be something like £5,000, as it is a very heavy class of cable. That, however, is not a very great matter. I don't know any telegraph company—and I am connected with many others—which has required so little money to be expended on repairs as in the case of this Company. It has had singular immunity, and in that respect this Company is the envy of every other telegraph company in the world. The next matter I have to refer to is your traffic. For the half year there was an increase of £675. Each half year in all companies has a different value—that is to say, there is one half year of considerable value, but in the other half year the traffic goes down. Comparing the last half year, however, with the corresponding period of last year there is an increase of £4,600; and the increase from the 1st of January to the 14th

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April in our traffic has been £3,060, while the working expenses have decreased by £243. That is all I need say about the traffic. I have to refer now to the resignation of our director in Brazil, Mr. Pinto. He had to leave us because he was called to join the Ministry, but I am happy to say that we have appointed another good man, who has acted as our solicitor for a great many years out there, to represent us. It is not likely you can know of the daily, the constant correspondence respecting your affairs in Lisbon and Brazil, necessitating gentlemen of influence to represent us with whom we can correspond, and whose time we can call on for that purpose in the distant parts for our system. We are especially fortunate in having Mr. Silva to represent us at Lisbon. I have here a few remarks as to Mr. Jay Gould's opposition cable, but I don't think I need say much about that. We only know that Mr. Gould has a concession for an opposition cable to go from Brazil to North America. Whether he will lay it or not I don't know, but I may as well tell you plainly that the traffic he would compete for, is about fifteen per cent. of your gross traffic. If, therefore, he does lay the cable it might become a matter of competition as regards the traffic, but we have so much in our favour as to the European traffic that I do not fear at all. I should not sell a share for that, so far as I am concerned. I don't know that there is anything more worth taking your time up with. This is a very nice report, and very short; and everything is before you so completely that really nothing is left for one to say. All our investments are there stated; and the traffic is given for each month since the line was open. The cable is in good working order; the reserve fund is growing, and if the traffic goes on as it is now, we hope to pay you a still larger dividend next year. With these remarks I beg to move, "That the report and accounts of the directors to the 31st of December, 1881, now submitted, be received and adopted."

Mr. Frederick Youle seconded the motion, which was carried unanimously, without discussion.

On the motion of Mr. J. Anderson, seconded by Mr. Lewis Wells, a vote of thanks to the chairman and directors was passed.

The Chairman briefly acknowledged the vote, and the meeting then separated.

THE RIVER PLATE TELEPHONE AND ELECTRIC LIGHT COMPANY (LIMITED).

The statutory meeting of this Company was held on the 12th inst. at the offices, 6, Lombard-street, Sir Julius Vogel, K.C.M.G., the chairman, presiding.

The Secretary (Mr. Charles Curtoys) having read the notice convening the meeting,

The Chairman said: Gentleman, I am very sorry that anyone has taken the trouble to come to the meeting, for there really is no business to transact. The secretary omitted to state in the circular that there is no business. This meeting is simply held because the law requires that within four months after the registration of the Company the first general meeting should be held. There is no business to transact, but as regards the progress of the business I may say that the Company has taken over the business for Buenos Ayres; we have a local board, a very good local board; we are extending our operations daily, and I hope the business will turn out to be a very good business. I have no resolution to propose. Several shareholders at this moment entering the room, the Chairman continued: I may say, for the benefit of the last shareholders who arrived, that this is merely a statutory meeting, there is no business to transact, and all I have to report is that we have taken over the business in Buenos Ayres, that we are extending our wires and increasing our number of subscribers every day, and our manager there and the local board seem to have the opinion that we have a very fine chance there. I hope it will prove so. The difficulty hitherto has been in supplying a sufficient number of telephones.

Mr. Freeman: What is the nature of the concession from Buenos Ayres? Is it anything in the shape of a monopoly?

The Chairman: We have no special concession. We have the right to run wires, but not an exclusive concession. We have the right to run wires and to carry on the business of telephone exchanges.

A Shareholder: What is the number of our subscribers at present?

The Chairman: About 300.

A Shareholder: Anybody else can do the same thing.

Mr. Curtoys: Well, we have an established system.

The Chairman: There is one other company at work there.

A Shareholder: There will be two centres for exchanges.

The Chairman: We have five exchanges already, and we are opening one at Montevideo. At Montevideo we have some exclusive rights. We have, in fact, exclusive rights in Buenos Ayres. The Pan Telephone Company has also exchanges, but our manager reports the Pan subscribers are daily coming over to us.

A Shareholder: Is it not a very confusing state of affairs to have more centres in a town than one?

The Chairman: Well, of course it is better to have one, and we are negotiating to amalgamate the two, but I am not in a position to give you the particulars; but in either case we are quite satisfied with the prospects of our own system. The Pan telephone is a new telephone. I do not think it is any use in any part of the world except Buenos Ayres.

A Shareholder: The electric light is a different thing altogether.

Mr. Curtoys: The electric light we have not done anything with.

The Chairman: We are in treaty for obtaining the Edison light, but we have not arrived at a conclusion yet. As there is no business to do, if there are no more questions to be asked we will declare this meeting at an end.

Mr. Adams proposed a vote of thanks to the chairman.

Mr. Panser seconded the motion, which was put and carried unanimously.

The Chairman: I hope we shall give satisfaction. I believe we have a very good property, and one we shall be satisfied with.

The proceedings then terminated.

THE HAMMOND ELECTRIC LIGHT AND POWER SUPPLY COMPANY (LIMITED).

The statutory meeting of this Company was held on Thursday at the Cannon-street Hotel, Sir C. L. Young in the chair.

The Secretary having read the notice convening the meeting,

The Chairman said: You are aware, gentlemen, that this is merely a statutory meeting of the Company, which is called simply for the purpose of satisfying the requirements of the Acts of Parliament regulating joint stock companies under the Limited Liability Act. To-day we have no accounts to submit to you. We have no report to offer for your adoption; but perhaps you would like to have some sort of idea of what we have been doing in the brief period of our existence. You are aware, from statements in the original prospectus of the Company, that we purchase from Mr. Hammond the whole concessions that he has obtained from the Anglo-American Brush Corporation for using and selling this apparatus for producing the electric light on their system in the important counties of Northumberland, Cumberland, Westmoreland, Durham, Lancashire, Yorkshire, Hampshire, Isle of Wight, and Sussex, and also certain valuable privileges he has secured from the Brush Corporation in the City of Westminster. Now, the consideration we gave Mr. Hammond for this was £35,000, in fully paid shares, and also certain founders' shares, which are entitled to participation in the profits of the Company after 10 per cent. has been paid to the shareholders, and after a certain amount has been set aside for reserve fund. Considering the values which, in public estimation, these concessions have risen to in the provinces, I do not think this amount can be said to have been a very extravagant one. After the formation of the Company we acquired from the Brush Corporation the concessions for Warwickshire, Staffordshire, and Worcestershire for the sum of £6,000, the amount for which Mr. Hammond had originally secured them. Well, gentlemen, when we accepted the responsibility of the conduct of your affairs we found that we had a very excellent basis to start upon. Mr. Hammond had been pretty well round the country, certainly in the north, and you know what a good thing it is to have a good beginning, and "nothing succeeds like success." The Brush apparatus, as you are aware, has been subjected to severe tests and to severe competition, but the proprietors have never been afraid of either, and I think, so far, the results have amply justified their confidence. We have been able in various parts of the country to demonstrate the great utility of the Brush light for every purpose where extensive lighting is required, and where it is available; and, without going into any details to-day, I may state after an exhaustive trial of our arc light with a sixteen-light apparatus it was found to be perfection by parties who tried it, and they have ordered a forty-light apparatus for the autumn. You will understand that the period of the year was not the most favourable for the introduction of artificial lighting. People do not think so much of that when the days are drawing out as when they are closing in; but the assurances we have received have been such as to justify us in giving large orders to the parent companies to enable us to meet all the demands which we believe we shall be called upon in the autumn to supply. We have been successful in cotton mills and in iron mills, where the dust and the dirt render the working of the electric light somewhat difficult, but over these difficulties we have been able to triumph. The well-known Oldham firm, Platt Brothers, has given us an extensive trial, and has eventually adopted our system. We have had success in galvanising works, and, I am very happy to add, we have been selected by one great railway company in the north to do their electric lighting, and we have already erected considerable plant for that. We have great confidence that another railway company in the north will shortly give us an extensive order for the purpose of replacing a defective system of electric lighting which they had had at work; and, I dare say, you may have observed some time ago in two or three of the London papers it was stated that at railway stations the electric light had proved a failure. The papers did not mention that that was one system only, and I saw very much the same observation made again last night. I am not going to trouble you much to-day, as I think Mr. Hammond would like to have a word or two to say. With regard to the formation of sub-companies, we have thought it the wisest policy to endeavour to enlist local sympathy and local assistance by the creation of local companies, and accordingly we have entered into agreements with parties in different towns and cities, and counties, to which, for a consideration, we hand over our rights and concessions, but at the same time we so contrive our agreements that we retain a valid interest, and do not lose all those interests in those counties, and towns, and cities. We have received special offers from responsible persons for the privileges we possess in certain counties, and also for the City of Westminster. We think these sub-companies will be of very great service to us, and the business that will speedily arise through their formation will be a source of considerable profit. Well, I do not propose to detain you any longer. It is enough to add we have very great confidence in the material at our disposal, and we look forward cheerfully to the future. It has become almost a common-place remark to say that the electric light is in its infancy. I dare say it is in its infancy, but it is a very fine and promising infant, and it scarcely requires a prophet to say that probably its adolescence will justify the promises of its youth. We have to fight with vested interests, and with great monopolies, and those do not die easily. However, nothing runs into perfection all at once, and we must have a little patience. We must not expect an immediate revolution in the systems of illuminating our streets and our public places and our private dwelling houses and our manufactories. All changes that are worth having come after experiment and patience. You will remember how it was said once by a very able writer, "We have given the lightning a situation in the Post Office;" I can only say I think we are now on the eve of the time when electricity is going to be called to give us some of the greatest benefits of modern times. Now, I think Mr. Hammond would like to say a word or two to you.

Mr. Hammond said he felt some difficulty in knowing exactly what ground to take up before them that day. Their Company was, of course, on the threshold of its career, and though during the past three or four

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months they had had very satisfactory results from its working, it would, perhaps, be more in order if he should start by giving a summary of what they were likely to do in the future rather than refer to what had taken place during what he must call the babyhood of the Company. He ventured to dwell for a short time on this point, because with the whirl of excitement that was going on at present it behoved those who were foremost in the business of electrical engineers to be calm and perfectly to understand their position, and the shareholders of any company, certainly such a company as theirs had become, should go away from this meeting knowing something about the property that they possessed and the prospects that were before them. He said that the Hammond Company had taken up the position of being electrical engineers. Now, in the applications of electricity there was one branch which stood foremost, and that was electric lighting. In fact, electric lighting had taken so strong a hold upon the public, that one was apt to forget that there was anything else connected with electricity; but in addition to electric lighting there was also the question of power, and without attempting in any way to detain them unnecessarily, he would like to say two or three words on the question of power. In many places throughout England there were manufactories which were compelled to waste a considerable amount of power every night. There were mills which, in the ordinary course of their business, generated an immense amount of heat, and if that could be utilised it could be converted into power, or into energy, which afterwards could drive the machinery, and which, indeed, could drive machinery at a distance. Therefore, there was ample scope for an electrical engineer who carefully kept his eye on every branch of the subject to work out a most lucrative business in utilising the waste power which at present was lost. In many places this waste power took place at a spot where the power was not so useful as at a distance. They were probably aware that, by the help of the dynamo machine, they were able to transmit the power. It was, in fact, transmitted to a colliery some fifteen miles distant, and, although the opponents of the Brush system said it would take a wire as thick as his hat, they were able to do it with a wire as thin as a quil pen. There was a colliery in the north of England where a 300 horse-power engine was used 1,000ft. below the ground. It was evident that the amount of cost contingent on such a scheme as having 300 horse-power pumping water below would be much minimised if all the machinery were at the top, and if by the substitution of a wire the power was conveyed down below. He thought it was well to dwell on the question of the latent force which they had not yet touched, but which might prove most lucrative in the future. With these few words with regard to power he would turn to what was more familiar to everyone—the question of lighting. Now, it had been said within the last two days by one of the leading journals that the electric light was not wanted, that the *furore* which exists in every direction with regard to electric lighting was a great mistake, that practically the Hammond Company had talked a good deal, they really had done nothing worth speaking of, and certainly had done nothing which had helped forward the work in any particular direction. Now, if they were in such a position that only those people would take their electric light who fancied it, or happened to be shareholders of the Company, he was going to say that they would be, of all men, the most miserable. They must show that there was a reason for the electric light Now, the question of lighting most familiar to Londoners was the question of the lighting of houses. They were aware of the fact that the lighting of a man's business premises was much more important to him than the lighting of his home; the application of a new thing there was more essential to him than its application to his house. For instance, a man grudged no expense which he thought beneficial to his business; whereas a man looked twice at a £5 note in household expenses, and, therefore, though he regarded the lighting of houses as of immense importance, he put it aside for a moment while he dwelt on the lighting of business premises. Throughout this country there were firms which carried on their operations day and night, as far as it was possible to do so; but in many of their premises it was utterly impossible to carry on some operations by any artificial light except the electric light. He made the statement advisedly, and he said it with all confidence. He would give an instance. They were all familiar with the process of rolling blooms of iron, as they were called technically in the trade, into iron rails, and blooms of steel into steel rails. The operations at large works, like those of the Ebbw Vale or the Bolckow-Vaughan, were most rapid. The iron stone was excavated from the hills in the morning, it was brought into the works, and the next day it was shipped in the form of finished rails. Now, when they were dealing with a company whose capital was £2,000,000, and whose out-turn of rails reached 8,000 tons per week, they would readily understand that every part of the works must be so constituted as to keep pace with the other. When the steel was rolled out into rails they were turned out all straggling and crooked, and they had to lie on the ground until the next morning, because the process of straightening those rails was impossible to be done by night. At Bolckow-Vaughan's they had tried various processes to light up what was technically called the rail bank. They found it impossible. Well, this Company had made it possible by the aid of the electric light, and works like Bolckow-Vaughan's, that otherwise would have to double the cost of the plant in particular directions, were enabled to use the same plant night and day by this new artificial light. Manufacturers had also told them that, since they had had the electric light the working power of their men had been uniform throughout the day, and the work done before eight o'clock formerly was practically only 50 per cent. of the work done now, and the work done after four o'clock was 50 per cent. less than that which was done now. Not only, therefore, could idle plant be utilised during the night, but better work could actually be got. The late Mr. Gibb, engineer to the Palmer Shipbuilding Company, built a shop some few months since, having no gas whatever in it; he whitewashed it, and asked the Company to come in and see what they could do. The shop lighted with the electric light, and with not a single jet of gas, actually yielded 25 per cent. better results than the one lighted by its side with gas. The men got twenty-five per cent. better wages, because they were paid by the piece; but it was an immense thing to feel that by the use of their light twenty-five per cent. more work could be obtained. Having referred to the question of house lighting, he said it had been asserted that fifty new electric lighting companies could be started every day, but he contended that none could be started with a sound basis. He referred to several failures which had been made by similar undertakings, and stated that it was the fault of the systems and not of electric lighting. In conclusion, he expressed his greatest confidence in the future of the Company.

A vote of thanks to Mr. Hammond, and also to the chairman and directors, terminated the proceedings.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices May 17.	Business Done Week Ending May 17. Highest.	Lowest
Anglo-American	55¾, 56	57¼	54¾
Do. Preferred	87½, 88	89	86
Do. Deferred	25½, 26	26¼	25
Brazil Submarine	11¼, 11¾	11 7-16	11¼
Cuba	8½, 9	—	—
Do. Preference	15½, 16½	—	—
Direct Spanish	5¾, 6¼	5⅞	—
Do. Preference	14¾, 15½	—	—
Direct United States Cable	12¼, 12¾	13	11¾
Eastern Telegraph	10½, 10⅞	10⅞	10½
Do. 6 per Cent. Preference	12¾, 13	13 1-16	12¾
Do. 5 per Cent. Debentures, 1899	102, 107	104½	—
Eastern Extension	11¼, 11¾	11 11-16	11 9-16
German Union	9½, 10	10	—
Globe Telegraph and Trust Company	6½, 6¾	6 11-16	6
Do. Preference	12¼, 12½	12½	12¼
Great Northern	12¾, 13¼	13½	12¾
Indo-European	28½, 29½	—	—
Mediterranean Extension	2, 2½	2	—
Do. Preference	8½, 9	—	—
Reuter's	12¾, 13¼	12½	—
Submarine	260, 270	269	—
West India and Panama	1¾, 2	—	—
Do. 1st Preference	8¼, 8¾	8¾	—
Western Brazilian	7¼ 7¾	7½	7½
West. Union 7 per Cent. 1st Mortgage	121, 126	—	—
Do. 6 per Cent. Sterling Bonds	102, 105	—	—

TELEPHONES.

Consol. Telephone and Maintenance	2, 2½	3	1 11-16
Oriental	½, ¾	1½	7-16
United Telephone	17, 17½	19	15

ELECTRIC LIGHT.

Eastern Electric Light and Power	6½, 7	9½	4½
Electric Light and Power	1¼, 1¾	1¾	1
Anglo-American Brush (£4 paid)	25½, 26	31	19

TRAFFIC RECEIPTS FOR APRIL, 1882.

Companies.	April, 1882.	April, 1881.	Incrse.	Decres
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,800	3,193	607	—
Direct Spanish Telegraph Company	1,824	1,337	487	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	29,269	26,746	2,523	—
Eastern Telegraph Company	42,667	45,289	—	2,622
Great Northern Telegraph Company	17,640	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

ELECTRIFIED WINE.—M. A. Angelier writes to *La Nature* detailing some experiments made by him to ascertain what effect electricity had in mellowing wines. In reference to the note published by our contemporary in a recent issue, which we reproduced, he says:—"I made a kind of voltameter by piercing the bottom of a jar of about two litres capacity, so as to admit two platinum plates, the electrodes, which I connected to the terminals of the machine (a Gramme) by silk-covered copper wires of small diameter, but corresponding in diameter with the section of the platinum plates. Although the use of electrodes and wires of larger size gave me a more rapid action, I preferred to use small ones, because the gases, by disengaging more slowly and in less quantity, were better able to penetrate the mass of the liquid, and so the more completly to reduce the salts and acids of the wine. All having been arranged, I poured two litres of very acrid wine from Lyons into the jar, and then completed the circuit. I could not measure the intensity of the current, having no instrument for the purpose, but, according to the gas evolved at the electrodes, I estimated it at three or four ampères. After fifteen minutes I tasted the wine, as also did several other persons present, and we found it much less acrid, and more soft and mellow. I continued the experiment for another quarter of an hour, after which we again tasted the wine, and found that it had been quite transformed; it was no longer acrid, and had a mellow and agreeable taste. Its bouquet had not changed in any apparent manner. A longer period of treatment did not seem to me to add much to the results obtained in the thirty minutes. Without doubt for this quantity (two litres) this time is enough. I renewed the experiments on several occasions, and on different qualities of wines, and always observed the same effects."

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

2492. Improvements in Electric Lamps, &c., *P. Jensen, London.—8th June,* 1881.—(*A communication from T. A. Edison, New Jersey, U.S.A.*). 8*d*.

This invention refers to a method of sealing the glass globes of incandescent electric lamps, so as to maintain a good vacuum, and is an improvement on patent No. 578, dated 10th February, 1880. The required glass having been blown into a bulb, this is broken away from the blowing rod at the tapered end sufficiently to leave room for introducing the carbons. Upon the semicircular end of the bulb a small opening is made and a tube formed thereon, by which to exhaust the lamp. A small piece of tubing is then taken, and an enlargement blown therein of a diameter about equal to the aperture above referred to in the taper end of the bulb. The leading-in wires are then laid in this tube. One end is brought to welding heat and clamped down on the wires, hermetically sealing them in the tube. The wires are in three sections, a central bit of platinum for sealing into the mass of the glass, with copper extremities, one leading from the lamp, the other into it for supporting the carbon. The end of the latter portion is flattened and wrapped round the ends of the carbon, and this union may then be electro-plated. The carbon is then introduced into the globe, and the edge of the opening of the globe and the enlargement of the tube sealed at a welding heat. The globe is then exhausted through the upper tube, and when sufficiently exhausted the latter is fused and welded near the body of the globe. The specification also describes methods for utilising defective carbons by arranging them so that the more perfect side is the negative portion; also for automatically transferring the current from one circuit to another in case of breakage, &c.

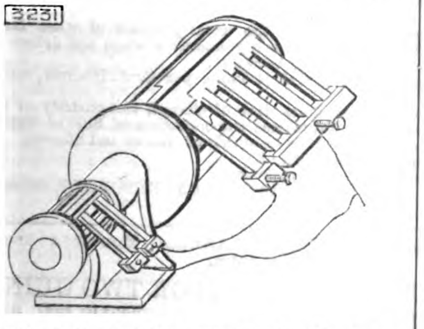
2532. Improvements in Electric Cables, *G. E. Gouraud.—10th June,* 1881.—(*A communication from P. B. Delany and E. H. Johnson, New York.*) 6*d*.

To avoid as much as possible the effects of induction the inventors form their cable of a number of insulated wires wrapped in a leaden covering. The method of construction is to take a lead pipe, flatten it out, leaving room between its sides for insertion of the insulated wires. These are then inserted so as to fill the pipe, and the latter is then passed between rolls which force the metal between the wires and fill all interstices, holding the wire in place and forming a flat cable. The wires are so arranged that at stated intervals their relative positions will be changed. Thus in a cable of six wires the order in the first section will be 1, 2, 3, &c., in the second 3, 1, 5, &c., in the third 5, 3, 6, &c.

3231. Improvements in Commutators for Dynamo or Magneto-Electric Machines, &c., *E. G. Brewer, London.—23rd July,* 1881. —(*A communication from T. A. Edison, Menlo Park, U.S.*). 6*d*.

The object of the invention is to reduce sparking; this is done as follows:—The insulation of the commutator is widened and the conducting bars narrowed at one end, and on this portion of

3231

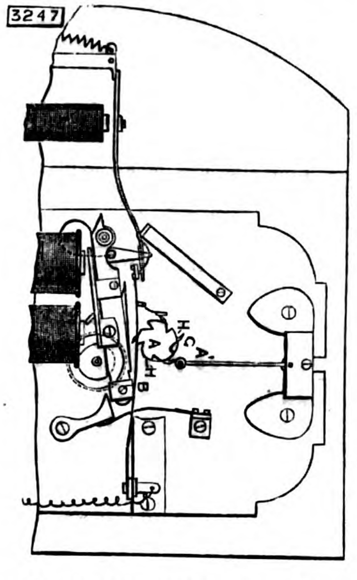


the commutator cylinder and at each side thereof a single isolated brush is arranged to bear, whose bearing end is noticeably behind the ends of the main brushes, as shown in the figure. This brush is connected to a series of breaking points resting on a breaking cylinder, as shown.

3247. Self-acting Electric Clocks, *F. T. Reid, Exeter, and J. U. Valentine, Teignmouth.—25th July,* 1881. 6*d*.

A wheel A of ivory or other insulating material carries platinum points H H connected to a brass axis A[1], and revolving with the wheel of the clock

3247



train. A has a corresponding number of large insulated ratchet teeth G, which lift the contact piece B, causing the completion of an electric circuit, which partially winds up the clock and sets a relay to work, actuating the dials.

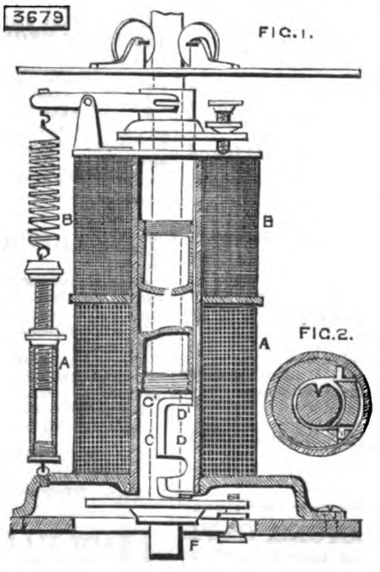
3650. Improvements in or Connected with Electric Lamps, *G. Pfannkuche, London. —22nd August,* 1881.—(*Not proceeded with.*) 2*d*.

Instead of enclosing the carbons of incandescent lamps in a vacuous globe, the inventor proposes to envelope them in a transparent body, such as glass.

3679. Improvements in Electric Light Regulators, *S. Pitt, Sutton, Surrey.—23rd August,* 1881.—(*A communication from S. J. Burrell, Brooklyn, New York.*) 6*d*.

Fig. 1 represents the regulator and upper carbon, which is movable. The action is as follows:—Core C D of coil A is in two sections. Core section C has two ears—see Fig. 2—to which lower end of section D is pivotted. The ends C[1] D[1] of

3679

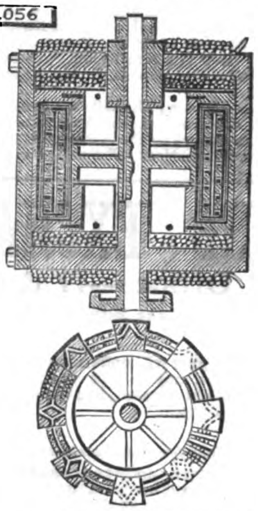


the two sections of the core being of similar polarity repel each other; this causes end of section D to be pressed against and grasp carbon F, and the whole core being also free to move upwards the upper carbon is separated the required distance from the lower one. Coil B is of thin wire, and acts as a shunt circuit for maintaining a constant resistance. The current is conducted to the carbon by the rollers shown.

254,056. Dynamo-Electric Machine, *William E. Sawyer, New York, assignor to Bernard Lande, same place.—Filed December 3rd,* 1881.

Brief.—The pole pieces of the field magnets nearly surround the cylindrical armature within and without. The armature is cast in one piece, and has air passages extending through those portions upon which the wire is wound, and having external openings in the polar extensions. *Claim.*

254.056

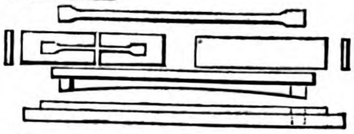


—A ring armature on the Pacinotti principle, composed of one piece of metal, and having air passages extending through the parts on which the induced conductor is wound and out at the external periphery of the polar projections, substantially as and for the purpose set forth.

254,672. Carbon for Electric Lamps, *Hiram S. Maxim, Brooklyn, assignor to the United States Electric Lighing Company, New York, N.Y.—Filed April 25th,* 1881.

Claim.—The process of manufacturing carbon conductors for incandescent lamps by first carbonising at a high temperature in flask sheets of proper material, then cutting or punching from

254.672

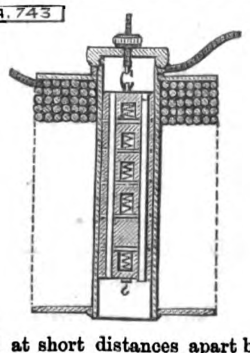


these the conductors in any desired shape, and lastly heating the said conductors in a carbonaceous gas or vapour, substantially as set forth and described.

254,743. Electro-magnet, *Addison G. Waterhouse, New York, N. Y., assignor to the United States Electric Lighting Company, same place.—Filed August 1st,* 1881.

Claim.—(1) An electro-magnet consisting of a hollow core of non-magnetic metal, having a coil or coils wound thereon, in combination with a core composed of independent sections of iron,

254.743



suspended at short distances apart by means of connections passing through the sections, which allow the sections to be drawn together when magnetised, substantially as described.

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CRYSTAL PALACE.

INTERNATIONAL ELECTRIC EXHIBITION.

LAST WEEKS OF THE INTERNATIONAL ELECTRIC EXHIBITION.

The present Exhibition will CLOSE on JUNE 3rd.

This Exhibition forms the MOST COMPLETE EXHIBITION OF ELECTRIC LIGHTING EVER SEEN.

The Tropical Department is lighted by the Anglo-American Brush Light Corporation; the Roman and Mediæval Courts, and a portion of the North Nave, are lighted by the Electric Light and Power Generator Company; the Greek and Renaissance Courts, and the North Nave between, by the National Electric Light Company; the North Nave, near the Centre Transept, by the British Electric Light Company; the Handel Orchestra and Pompeian House by Messrs. Rowatt and Fyfe; the Centre Transept by Messrs. R. E. Crompton and Co.; the Concert Room and Entertainment Court by the Edison System; the North End of the South Nave by Messrs. Strode and Co.; the adjoining portion of the South Nave, the Birmingham Court, the Scientific Court, and Negretti and Zambra's Studio, by M. Gravier; the South End of South Nave by Gerard and Co.; the Railway Corridor, leading to the L. B. & S. C. Railway, and a portion of the West Corridor, by the Hammond Electric Light and Power Supply Company; the South End of Palace, by Messrs Siemens Brothers and Co.; Part of the Picture Gallery, and various other portions of the Exhibition, by Swan's Electric Light Company; the remainder of the Picture Gallery by the White House Mills Company, of New York; the Western Gallery by Messrs. G. Hawkes and Co.; the South Gallery by Mr. G. G. André; and the Opera Theatre and adjoining Avenue by the Compagnie Générale d'Electricité.

The Non-Lighting Exhibits comprise the finest collection ever brought together of Telegraphs, Telephones, Signals, Batteries, Electric Motors, Electro-Medical Apparatus, Electro-Chemical Apparatus, Cables, Wires, Lightning Conductors, Electro-Magnetic Machines, Dynamo-Electric Machines, Magnets, Electric Clocks, &c.

No extra charge to the Exhibition. The Palace Main Entrances, South Entrance, and Entrances at the Railway Stations, will be open for admission till 9:45 p.m. daily till further notice. The outlying Entrances will close at 7:30 p.m.

THE EXCHANGE TELEGRAPH COMPANY, LIMITED.

Head Offices--17 & 18, Cornhill, E.C.; Stock Exchange, E.C.; 27, Regent Street, W.

Incorporated the 28th March, 1872, under the Companies Acts of 1862 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

Not having any springs or clockwork to wind up or to depend on, these instruments are acknowledged by those familiar with the system of telegraphy to be the only instruments yet invented that are capable of doing the work required of them continuously for a lengthened period, as evidenced by the fact that the Gold and Stock Company of New York, having the monopoly of this kind of business in the States, and which owns all the patents of the day of any value, has, after due trial, discarded all others.

The Company is prepared to treat with provincial Companies requiring instruments for the delivery of news for either single or double wire systems under the Company's patents, whereby from central stations identical information can be simultaneously delivered to any number of recipients by automatic, self-adjusting, printing instruments requiring no local batteries, no winding up, and no knowledge of telegraphy on the part of the receiver, the printing being in bold roman type, and the propulsion of the paper being effected by the electricity supplied from the Central Office.

The instruments supplied by the Company can be had to work either on single or double wires, and to print either on a slip or tape of paper, as has hitherto been the custom, or on a broad band of paper in column form.

The system has been in use by the Exchange Telegraph Company (Limited) in the City and West End of London since 1872, and by MacMahon's Telegraphic News Company (Limited), for the delivery of Parliamentary, Sporting, and General Intelligence, since 1879.

The Company will supply householders and others with its

DISTRICT CALL SYSTEM.

By the aid of a small automatic telegraph instrument a Subscriber can at any hour, day or night, call a messenger, cab, or policeman, or give the alarm of fire, and will obtain the required assistance within three minutes of making the signal. Subscribers, when absent from their homes for a season, can leave their houses closed, and have them taken charge of by the Company, and rendered perfectly secure against burglars by a telegraphic communication with the nearest District Call Station of the Company, where a policeman will always be in readiness day and night to respond to calls.

Provincial combinations to work under the Company's Patents will be treated liberally.

The Company is also prepared to supply Municipalities with its system of

STREET FIRE ALARMS

as recommended by H. M. Postal Telegraph Department to the Metropolitan Board of Works for the Metropolitan Fire Brigade, and which has received favourable mention by Captain Shaw in his last annual report.

These Alarms have recently been considerably improved by the Company, and are acknowledged to be the simplest yet constructed.

All communications to be addressed to the Secretary as above.

THE DIRECT UNITED STATES CABLE COMPANY, Limited.
ALTERATION OF TARIFF TO TWO SHILLINGS PER WORD.
"Via DIRECT CABLE."

On and after the 22nd May, 1882, and until further notice, the CHARGE for the TRANSMISSION of TELEGRAMS "Via DIRECT CABLE," between GREAT BRITAIN or IRELAND and NEW YORK and CANADA will be TWO SHILLINGS PER WORD.

The name of the place from which Messages originate will be transmitted free of charge.

For rates to other places and further particulars apply at any of the Company's offices.

J. W. FULLER,
Secretary and Traffic Manager.

General Offices, 52, Old Broad-street, London, E.C.,
13th May, 1882.

LIFE ASSOCIATION of SCOTLAND.
Founded 1838.

HEALTHY PERSONS OF ALL AGES will find in the BONUS SYSTEMS of the LIFE ASSOCIATION of SCOTLAND advantages far exceeding those which can be obtained under any of the ordinary systems.

Claims and Bonuses paid.............................. £4,028,000
Annual Revenue 436,000

Immediate Entrants in Class A will secure ONE YEAR'S BONUS MORE THAN LATER ASSURERS in that class.

LONDON—5, Lombard-street, and 48, Pall Mall.
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TO MEDICAL ELECTRICIANS, INVESTORS, CAPITALISTS.—To be SOLD, the very advantageous and long LEASE, at nominal rent, together with the whole of the FITTINGS and FURNITURE of an ELECTRIC and TURKISH BATH INSTITUTION, now continuing. An established business, and capable of great extension. The building is large, and in first-class position, and eminently suited for Public Baths, &c. Address, in first instance, "Exors.," care of H. W. Nelson, 377, City-road, London, E.C.

WORKING ELECTRICIAN WANTED, to serve in shop. Useless to apply unless thoroughly practical in all branches. State age, wage, and all qualifications by letter to R. F. H., 60, Strand, London.

THE Advertiser, having just passed through a course of practical and theoretical instruction, is desirous of an Engagement as ASSISTANT ENGINEER in any Telephone or Electric Light Company. Address P. R., 98, Queen Victoria-street, E.C.

TO ELECTRIC COMPANIES, MANUFACTURERS, &c.—The Advertiser, who has had twenty years' experience in the driving and charge of stationary engines, wishes to obtain a SITUATION. Excellent testimonials for perfect sobriety and attention to duty, seven years in his last situation, thirteen in his previous one.—G. DAY, care of J. B. WEMYSS, Esq., Stonebridge Park, Willesden, N.W.

ESTABLISHED 1851.

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Current Accounts opened according to the usual practice of other Bankers, and Interest allowed on the minimum monthly balances when not drawn below £25. No commission charged for keeping Accounts.

The Bank also receives money on Deposit at Three per Cent. Interest, repayable on demand.

The Bank undertakes for its Customers, free of charge, the custody of Deeds Writings, and other Securities and Valuables; the collection of Bills of Exchange, Dividends, and Coupons; and the purchase and sale of Stocks and Shares.

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A Pamphlet, with full particulars, on application.

FRANCIS RAVENSCROFT, Manager.

31st March, 1880.

The Birkbeck Building Society's Annual Receipts exceed Four Millions.

HOW TO PURCHASE A HOUSE FOR TWO GUINEAS PER MONTH, with immediate Possession and no Rent to pay. Apply at the Office of the BIRKBECK BUILDING SOCIETY.

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FRANCIS RAVENSCROFT, Manager.

Southampton-buildings Chancery-lane

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SLIP

The Telephone in Africa.—A telephone exchange has been opened at Port Elizabeth, South Africa. The lines are of steel wire.

Electric Light in Brussels.—The buffet and restaurant in the Musée du Nord at Brussels are to be lighted by Edison incandescent lamps.

The Inductophone.—We are compelled, owing to the lengthy reports in this week's issue, to leave over an illustrated article on this apparatus till next week.

Electric Lighting for the City.—At a recent meeting of the Commissioners of Sewers it was stated that eight tenders had already been sent in for lighting the new districts of the City.

Royal Society.—The following paper was to have been read before this society by Professor J. A. Ewing, of Tokio, viz.:—"On Effects of Retentiveness in the Magnetisation of Iron and Steel" (Preliminary Notice).

The Telephone in France.—M. Cochery, the French Minister of Posts and Telegraphs, has asked the Chamber for a grant of 250,000 francs to enable him to establish a State telephonic service between certain towns in France.

Electric Light in Madrid.—It is stated that the Madrid Gas Company are about to introduce the electric light as a means of illuminating the Alcala-street. Gas engines and Siemens dynamo-machines will be used to generate the current.

Electric Railway.—The examiners of the House of Lords have reported that the standing orders have not been complied with. The Bill has, therefore, been referred to the Standing Orders Committee to decide whether it is to be allowed to proceed.

Electric Lighting Bill.—Mr. Johnson, the agent here of Mr. Edison, in his evidence before the committee, has given a mass of interesting information about incandescent lighting, its cost, &c. The abstract of this evidence will be given in our next issue.

The Telephone in Newcastle-on-Tyne.—The Northern District Telephone Company, who opened a telephonic exchange in Newcastle some three months ago, have now about 120 subscribers in communication. These are chiefly resident in that part of the town known as Quayside.

Electric Light in Salford.—We believe that the Edison incandescent lamp will shortly be in use in several factories in Salford, near Manchester. Amongst others, Messrs. Platt Brothers will employ this light. The lamps and machines will be erected by the Edison Electric Light Company.

Electric Light in Constantinople.—*La Lumière Electrique* says that the large gardens surrounding the Sultan's Palace at Yildiz-Kiosk are to be lighted by electric lights. The necessary machines and apparatus have arrived, and have been tested by the officials of the Ottoman Admiralty.

Fire Risks and Electric Lighting.—The name of Mr. J. E. H. Gordon was accidentally omitted from the list of the committee appointed by the Society of Telegraph Engineers and of Electricians to consider this question, which was given in our last issue. Mr. Gordon was, we believe, the original promoter of the investigation.

Legal.—An action brought by Mr. George Twigg, of Birmingham, against the British and Irish Telephone Company for damages because of the fall of a chimney stack to which telephone wires had by permission been affixed, resulted in a verdict for the defendants, on the ground that the "wire was not the cause of the chimney falling."

South American Cables.—We are informed that the ss. "Silvertown" has safely arrived at Santa Elena with a large portion of the cable for these lines on board. The "Silvertown" will at once commence to lay her cables towards Salina Cruz, near Tehuantepic, in Mexico. The ss. "Dacia" returned from her work on the West Coast of America, and arrived at Liverpool on the 22nd inst., "all well."

Electric Light in Vienna.—We learn that experiments have been made in Vienna to decide the question of lighting the new Reichsrath buildings. The magnificent peristyle of the building was lighted from above, the light being diffused through glass. The large hall was lighted by numerous lamps, and a lustre of sixty lamps was placed in the meeting hall of the Austrian delegates. The experiments are said to have been satisfactory.

The Edison Light in Philadelphia.—A *Times* telegram, dated Philadelphia, May 19, says that Edison's incandescent light has been introduced in the composing and stereotyping rooms of the Philadelphia *Public Ledger*, and used successfully for three nights, entirely replacing gas. Seventy-four lamps are used, of 16 candle-power each; and the electricity is furnished by one dynamo mechine, driven by a special engine. Eight lamps are supplied for each horse-power.

Fires in New York.—According to the report of the New York Fire Department for 1881, there were 1,785 fires in that city during the year. Of these only four were attributed to electricity. In one case—at the Germania Theatre—the explanation given is, that the insulation of the wire running over a tinned arch above a street entrance being defective, the water of a shower led the current to the tin, it melted the solder, burnt the tin, and ignited the woodwork below.

Edison's Electric Light Meter.—In the report of the second of Mr. Day's lectures on the fire risks of electric lighting, given in our last issue, the Edison electric light meter is alluded to, in the latter portion of the report, as "Mr. Jehl's current meter." To avoid confusion we may say that the meter is the invention of Mr. Edison, and that Mr. Jehl is the gentleman to whom the experiments necessary to perfect the details of its construction were entrusted, and by whom they have been most thoroughly carried out.

Cable Repaired.—The Direct Spanish Telegraph Company announce that their direct cable communication with Spain, *viâ* Bilbao, is now restored. The repairing work was carried out by the Silvertown Company. The ss. "Oersted" was employed in the work. She left London on the 9th, but was unable to do any repairing work for four days, owing to the heavy weather in the Bay of Biscay. The fault was successfully repaired on Friday night, the 19th inst. M. A. le Neve Foster was in charge of the operations, and was assisted by Mr. A. S. Page. The "Oersted" returned to London on the 24th inst.

The Telephone Case.—In the Court of Appeal, on the 22nd instant, in the case of the United Telephone Company *v.* Harrison, Cox-Walker and Co., Mr. Cozens Hardy, Q.C., on behalf of the plaintiff company, asked that, notwithstanding that the judgment was not drawn up, the appeal, which it has been decided to bring, might be entered in the list, so that, should the state of business allow, there might be some prospect of the appeal being heard before the Long Vacation.—The application was refused, and it was stated that, until the Summer Circuits, the Court would be occupied with hearing common law appeals.—The judgment that has been

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pronounced in this case will be found in another part of our issue.

The Edison and Swan Lamps.—The solicitors of the Edison Electric Light Company, Messrs. Waterhouse and Winterbotham, have written to the daily papers, stating "That the board of that company are advised that the lamp known as the Swan incandescent lamp is an infringement of the Edison patents." The solicitors of the Swan Company, rejoining in the following issue of the papers, state that "they are advised that the Swan incandescent lamp is not an infringement of the Edison or any other patent. The Swan lamp has been before the public unchallenged for a considerable time, 1,200 of the lamps having been nightly in use for several months past at the Savoy Theatre alone."

The Telephone in Collieries.—Telephones have been introduced into the Manvers Main Collieries and the Oaks Collieries, and by their means conversation can now be carried on between the officers on the surface and the workings, which are more than a mile apart. The telephone apparatus, which consists of Johnson's patent transmitter and Bell's patent receiver, with a suitable ringing alarum for calling attention, has been erected by Messrs. Tasker, Sons, and Co., of Sheffield. For colliery work the telephone has proved most useful, and the wonder is that it has not been more widely adopted. As a saver of time and labour, to say nothing of being the only means of communication with the workings in cases of accident, the telephone is pre-eminently useful.

Electric Light in Theatres.—Experiments have been made in the Monnaie Theatre at Brussels, under the supervision of a special committee appointed by the city authorities, to study the best means of preventing fires in theatres. The lamps used were on the Lane-Fox incandescent principle, supplied with current from accumulators. The cables leading from the accumulators to the lamps, and also to the charging machine, were covered with insulating material having the character of asbestos and being incombustible. The motor and machine were placed in the cellars of the theatre, the former being of six horse-power. The stage was furnished with 39 incandescent lamps as footlights, the current supplied to them being regulated by a commutator of variable resistance. This instrument permitted the light to be modified by 10 degrees, without extinction, by the successive introduction into the circuit of decreasing resistances.

Thunderstorms.—Severe thunderstorms are reported as having taken place in the early part of this week in the Midland and Western districts. A terrific storm passed over Nuneaton on Tuesday afternoon, the lightning being peculiarly vivid. During the course of the storm a horse was killed by a flash of lightning on a farm at Badersley Ensor, near Nuneaton. On the same afternoon a boy named Albert Williams was killed by the lightning at Upper Gornal, near Sedgeley. Previous to the storm he was noticed on the top of a hay rick searching for birds' nests. He was afterwards seen to be knocked down by lightning. His body was badly burnt, and his hair was singed. Other persons had narrow escapes. At Wolverhampton the lightning struck a chimney stack adjoining the Peacock Hotel, and knocked it down. No one was injured, though the bricks fell into a room full of people who were dining at the Hotel. Severe storms are also reported as having passed over Cheshire and Holyhead.

Legal.—The case of the Midland Electric Light Company *v.* the Brush Midland Electric Light and Power Company was heard on Friday, the 19th inst., before Mr. Justice Chitty. It was a motion for an injunction to restrain the defendants from using the name of the Brush Midland Electric Light and Power Company, or any other name identical with or so nearly resembling the plaintiffs' name as to be calculated to deceive or mislead. The plaintiffs, whilst allowing that there was no intention of fraud in the defendants' adoption of their name, contended that the word Midland was the keystone of the name which had priority of registration, and that its presence in the defendants' name had, in fact, produced confusion between the two companies. —His lordship, without calling on the defendants, said that confusion between the two names could not arise in the mind of any person in possession of his senses. The plaintiffs' case failed altogether, and the motion must be dismissed with costs.

The Patent Laws.—In a leading article on the telephone case, *The Times* makes some allusions to the present state of the law relating to patents in this country. The article in question concludes as follows:—"It will hereafter be looked upon as a disgrace to our generation that inventors should be taxed to the extent which our present patent laws permit. They are a class to which the country owes much of its prosperity, and yet we withdraw enormous sums from their pockets, which are often the pockets of poor and struggling men, merely to give them a nominal and delusive property in the creations of their own brains, a property which amounts to little more than the right to defend themselves in a court of law if they are attacked. The demand is urgent for a reform by which patents will be granted with discrimination, by which the fees will be reduced to the lowest point compatible with the working of the necessary machinery, and by which some means would be provided of bringing disputes touching infringement under the cognizance of an inexpensive and a competent tribunal." The shadow of coming events makes these words of great interest to inventors in the electrical world.

The Telephone and the Post Office.—In the House of Commons, on Friday, the 19th inst., Mr. R. Martin asked the Postmaster-General when he would be able to state the conclusion at which he might have arrived as to granting a license to the London and Globe Telephone Company, authorising them to work in London and its suburban districts; and whether he had any intention of purchasing the business of one particular company at a large price, and thereby creating a monopoly of telephone service, by which the public would be deprived of the benefit of a helping competition in the development of a scientific invention, which might still be considered to be in its infancy.—In reply Mr. Fawcett said that he had received applications, not only from the London and Globe Telephone Company, but from other telephone companies for licenses to carry on business in various towns, where a telephone exchange is already established, either by a private company or by the Post Office. He was not yet in a position to announce his decision, but he could assure his hon. friend that there should be no unnecessary delay in arriving at a conclusion, and in making it known. He also stated that the Government had no intention of purchasing the business of any telephone company.

International Congress of Electricians.—*L'Electricité* says:—"The greater portion of the political papers have made the mistake of announcing that a congress of electricians would be held in Paris on the 1st May, 1882. We are in a position to state that there will be two distinct congresses. The object of the first will be to give force to the decisions of the congress of electricians (presumably the one held in September last), and the second to

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adopt international measures for the protection of cables. These two congresses are perfectly distinct from one another, and although both are convened by the Minister for Foreign Affairs they will take place at two different times. The same papers are also in error in giving the date of the meeting of the congress as the 1st of May. We can affirm that the 1st of June is the only date that has been spoken of in connection with the congress on electrical units. We do not think that the congress on the question of the protection of cables can be opened before the 1st of October, owing to the preparations which are now being made by the various Governments in order to formulate the instructions to be given to their representatives." *L'Electricien*, on the other hand, states that the congess on the question of electrical units will not be held until the 1st of October.

New Companies.—The following new companies have been formed:—The British Insulite Company, with a capital of £250,000, to work the patents of Dr. J. A. Fleming for a new material called insulite, and which is designed to supply a cheap and efficient insulating material. Mr. Latimer Clark is amongst the directors, and Mr. J. Hopkinson, F.R.S., is consulting electrician. The company's offices are at 44, Gresham-street, E.C., where the material can be seen.—The Duplex Electric Light, Power, and Storage Company is announced, with a capital of £100,000. It has been formed to work the patents of the "Duplex" system of electric lighting. According to the prospectus a combined generator and storage battery has been devised, which can be charged by hand and used for incandescent lamps.—The Yorkshire Brush Electric Light and Power Company, with a capital of £300,000, has secured a concession for the county whose name it bears from the Hammond Company, which includes the Brush machine and lamp, and the Lane-Fox lamp.—The Jablochkoff Electric Light and Power Company has a capital of £300,000, and is formed to work the Jablochkoff light and machine, and the Gatehouse automatic light changing apparatus. An agreement has also been entered into with the Electric Light and Power Company, by which that Company will supply the Jablochkoff Company with Maxim incandescent lamps.—The Swan United Electric Light Company has been formed to acquire the business of Swan's Electric Light Company, with its patents, &c., including the license to use the patents of Messrs. Swan and Sellon for the storage of electrical energy. An arrangement has also been concluded with Messrs. R. E. Crompton and Co., by which the company have acquired all their existing lighting contracts, and the right to the services of Mr. Crompton and his firm, together with the right of supplying his arc light. Mr. Swan and Mr. Crompton will join the board of the company after allotment as technical directors.

Subdivision of the Electric Light.—Mr. W. H. Preece, F.R.S., writes to *The Times* as follows, with reference to a recent statement made by Mr. Spottiswoode that a committee of the House of Commons had declared that "the subdivision of the electric light was not to be hoped for." Mr. Preece says:—"I think he must have had in his mind my evidence, which was to that effect; for the committee made no such remark. My statement was and remains strictly true. There is great confusion between the problem of the subdivision of the electric 'light' and that of the distribution of the electric 'current.' They are two totally different questions, which are generally mistaken for each other. If a given current, say that equivalent to one-horse power, will give a light, say of 2,000 candles, you cannot by any known means divide that light into twenty lamps of 100 candle-power each. The best that has hitherto been done from one horse-power is to obtain eight lamps of 16 candle-power each. You can, however, distribute the current in any way you please. If one horse-power will give you one lamp of 2,000 candle-power, or eight lamps of 16 candle-power, it is evident that 2 horse-power will give you two lamps of 2,000 candle-power and sixteen small lamps; 3 horse-power, three lamps of 2,000 candle-power or twenty-four small ones, and so on, directly by multiplication and distribution. Mr. Brush has shown how to multiply his lamps, and Mr. Edison has shown how to distribute his currents and multiply his lights, but no one has as yet attempted to solve the question of the subdivision of the electric light. The largest machine yet made, that of Edison, will maintain 1,200 incandescent lamps, giving 16 candle-power each, or a total light of 192,000 candles, with an expenditure of 150 horse-power. Such a power applied directly to the production of light ought to give a light of many million candles. Although I still maintain that the useful subdivision of the electric light is not to be hoped for, it is not to be assumed that I or any one else opposes the distribution of the electric current and the multiplication of electric lamps. This is now practically and economically within the reach of all."

Dimensions of a Magnetic Pole in the Electrostatic System of Units.—In the *Philosophical Magazine* for May Professor J. D. Everett gives the essence of a paper by Clausius, dealing with electrical and magnetic units. He says:—"Electricians are familiar with the fact that a circuit with a current flowing in it is a species of magnet, and that the moment of the magnet thus constituted is the product of the current by a certain area. Hence the moment of a magnet must have the same dimensions as a current multiplied by an area. That is, we must have Pole × Length = Current × (Length)^2; or, more simply, Pole = Current × Length. This equation must be true in any consistent system of units. In the electrostatic system, the dimensions of Current (or quantity of electricity divided by time) are $M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-2}$ (M denoting Mass, L Length, and T Time). Hence, by the above equation, the dimensions of a Pole are $M^{\frac{1}{2}} L^{\frac{5}{2}} T^{-2}$. This is substantially Clausius's reasoning, though I have for brevity somewhat altered its form; and it appears to me unimpeachable. Nevertheless, the result differs (as the author points out) from Maxwell's formula for the dimensions of a pole in the electrostatic system, namely, $M^{\frac{1}{2}} L^{\frac{3}{2}}$. This formula will be found in Maxwell's 'Electricity and Magnetism,' § 626, where the name 'quantity of magnetism' is used instead of 'strength of pole,' or the briefer name 'pole.' It will also be found in the reprint of 'Reports of the B.A. Committee on Electrical Standards,' page 90; but in neither work have I been able to find an explicit statement of the reasoning by which the result is obtained. Perhaps some reader of the *Philosophical Magazine* can give the necessary explanation. In my own treatise on 'Units' the question at issue is not raised, as practically the dimensions of a magnetic pole do not enter into electrostatic discussions. The dimensions of a pole, calculated in the ordinary way from the mutual repulsion of two poles, are $M^{\frac{1}{2}} L^{\frac{3}{2}} T^{-1}$; and from this, by considering the force exerted by a current upon a pole, the dimensions of Current in the electro-magnetic system are found to be $M^{\frac{1}{2}} L^{\frac{1}{2}} T^{-1}$. The relation between these two, it will be observed, fulfils the foregoing condition, Pole = Current × Length. It appears to me that Clausius's result must be accepted as the correct one." The editor of the *Phil. Mag.* announces that a full translation will be given in an early number thereof.

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AN ELECTRIC RAILWAY IN THE BLEACHING GROUND.

To the many industries which are indebted to electricity as a motive power must be added that of bleaching. In the particular instance under notice, electricity has been made use of to the exclusion of steam on account of its cleanly properties, if we may so call them. For obtaining motive power by means of steam it is impossible to prevent the production of smoke, and smoke in a bleaching ground, to say nothing of cinders and sparks, would be likely to injure seriously the material bleached. Consequently, if motive power is required, it should be supplied by an agency which produces no smoke, and no cinders. Electricity is exactly the agency required.

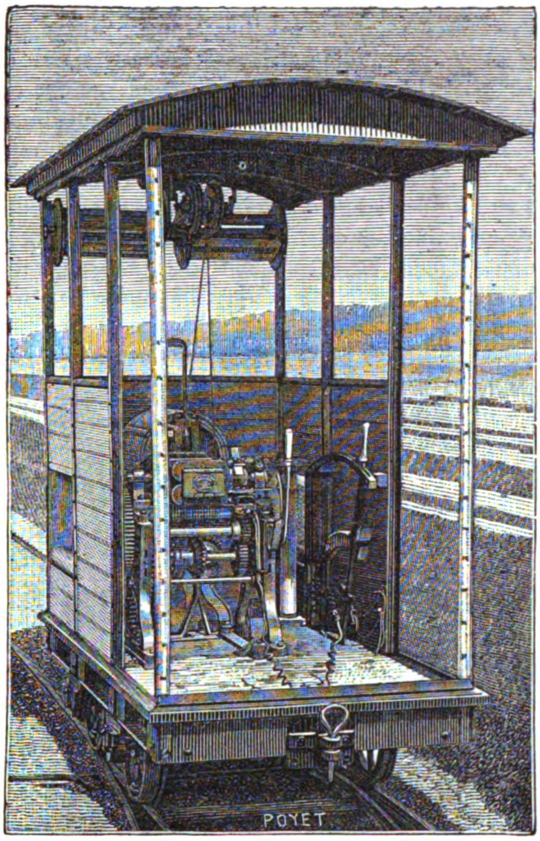

Fig. 1.—The Locomotive Car.

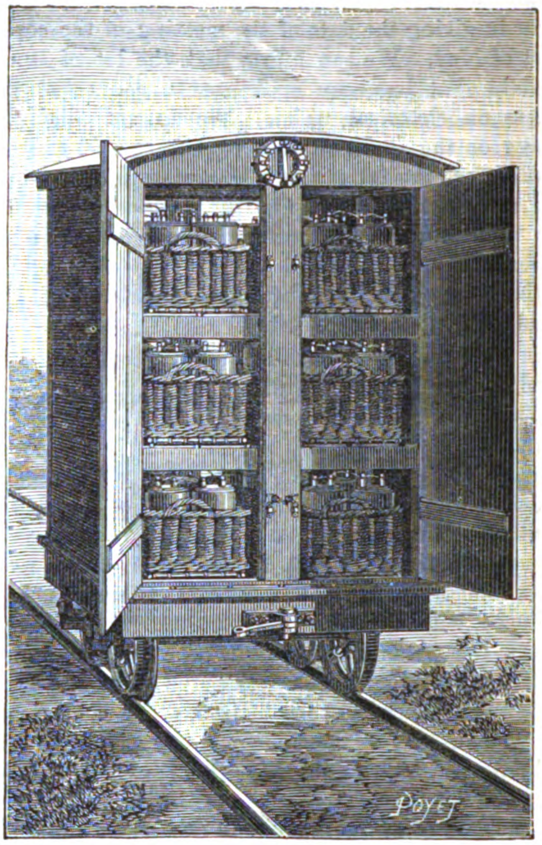

Fig. 2.—Tender carrying Faure Accumulators.

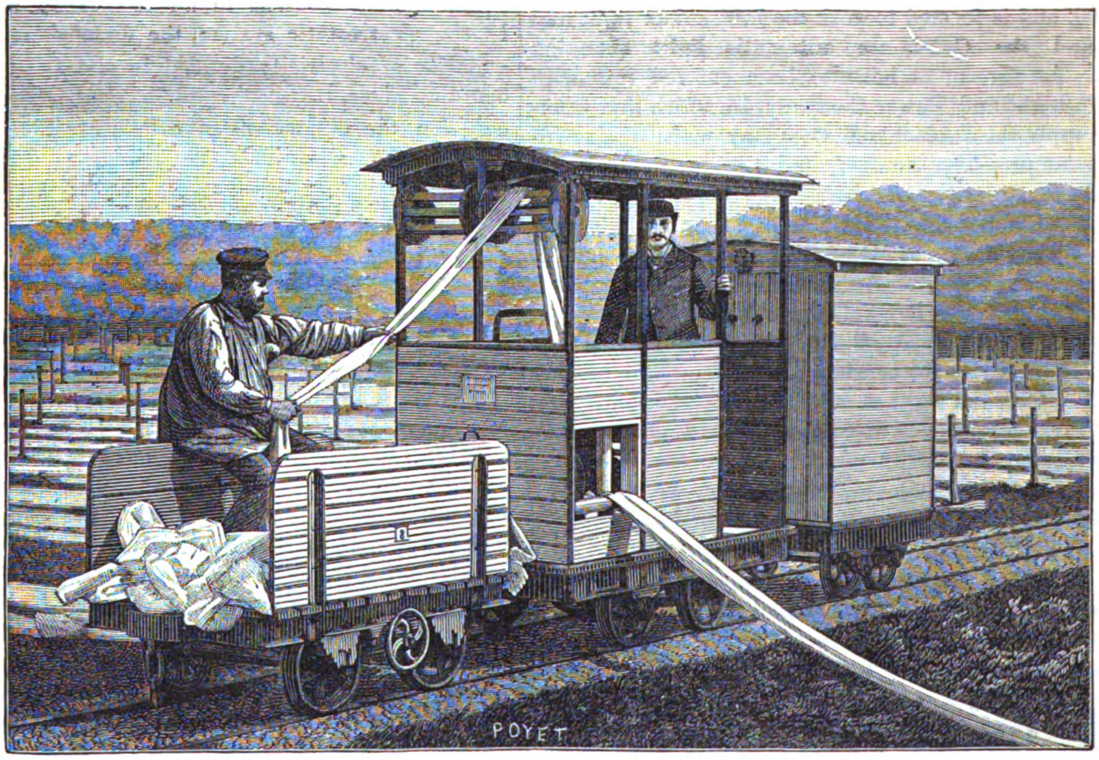

Fig. 3.—Showing the Mode of Hauling In, and also the Bleached Material.

The following account of the way in which electricity has been used to propel a train of waggons in a French

bleaching ground is taken from our contemporary *La Nature*:—

"The bleaching ground belongs to M. Paul Duchesne-Fournet, and is situate at Le Breuil-en-Ange. The establishment is a large one, and is controlled by the engineer-in-chief, M. Clovis Dupuy. The operation of bleaching consists of first treating the material chemically, and afterwards submitting it to the action of the solar rays in pieces or strips of 100 metres long. There are 15 hectares of ground, which are used for the laying out of these strips, so that the operation of taking them up after they have been sufficiently bleached is a lengthy one, and necessitates many workmen.

"The idea of gathering in these strips by special machinery carried on a railway suggested itself to M. Dupuy, but was rejected on account of the smoke and cinders which would be a necessary accompaniment of a steam engine. He then determined to try an electric railway, and accordingly constructed and worked the one we are about to describe.

"The train, which is set in motion by dynamo-electric motor (Fig. 1), actuated by Faure accumulators (Fig. 2), starts from the factory with empty waggons. When it has arrived at the bleaching ground it is brought to a standstill; the dynamo sets in motion the hauling-in machinery, between the rollers of which the end of the first strip of material is placed. The material is drawn in by the windlass rollers, passed over another roller in the top of the framework of the engine car, and thence to the waggon next it, where it is received by a workman and coiled or packed (Fig. 3). The further to save time, all the strips of material in a certain section of the ground are united to one another by their ends, so that one man can collect 5,000 metres of material in 30 minutes, a quantity which, under ordinary circumstances, it would have taken eleven hours to gather in.

"Fig. 4 shows the train fully loaded returning to the factory with 10,000 metres of material. We may now go into the details of the machinery.

"The motor, or locomotive (Fig. 1), consists of a reversible Siemens machine. A lever (Fig. 1 and Fig. 5), serves to start and govern the machine. In the vertical position shown in Fig. 5 the brake is on, and no current can pass to the machine. By lowering the lever contact is made, the rheostat chain (Fig. 5) is more and more extended, and the links make better contact, thus diminishing the electrical resistance and increasing the speed.* The speed of the train is thus varied according as the lever is moved in one direction or the other; when the lever is in the position of rest it at the same time applies the brake. A second lever is provided for reversing the direction of the train by acting on the brushes of the dynamo machine. A third lever enables the motor to be put in connection with the axle of the driving wheels, or with the machinery for winding in the material.

"A tender, attached to the engine car, carries Faure accumulators, large size, constructed by M. Reynier. They are

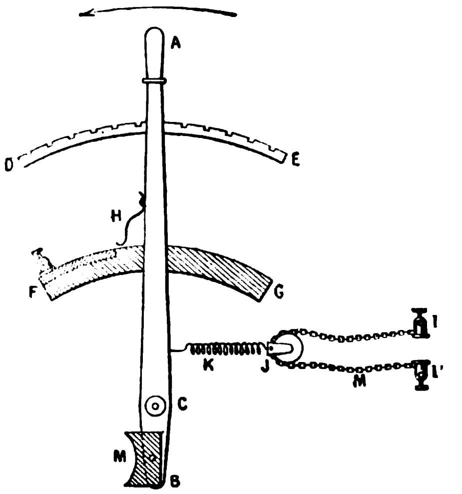

Fig. 5.—The starting lever A B C is the lever arm working between the two guides of the sector D E; F G a wooden sector carrying two contact plates, in connection with the cells; H a spring contact-piece; I J I' a rheostat chain influencing the general circuit. This chain passes over J, which is connected to the lever by a spring, K. M is the brake-shoe; C is the axis of the lever.

arranged in three rows (Fig. 2), in baskets, each of which holds six cells; there are four baskets in each row, excepting the third, which only contains two. Thus there are altogether sixty cells, weighing 500 kilogrammes. The weight of the locomotive is 935 kilogrammes, of the tender 700 kilogrammes, and of each waggon, filled, 800 kilogrammes. The cells are charged by a Gramme machine, which has been used since 1879 to give the current for the eleven Reynier lamps which light the factory. The horse-power available is 60. Three of this only is used during the charging of the batteries, which takes from five to eight hours.

"At the upper part of the tender is a commutator (Fig. 2), which permits the cells to be used in succession, beginning with a minimum of twenty-four, and increasing successively by six at a time, up to sixty.

"The railway as described has been at work for seven weeks or more, with advantageous results. The speed attained is 12 kilometres per hour, but in this particular instance great speed is not sought after or required. The time during which it can be worked is, according to the data of M. Clovis Dupuy, three hours, this time being limited by the charge of the cells."

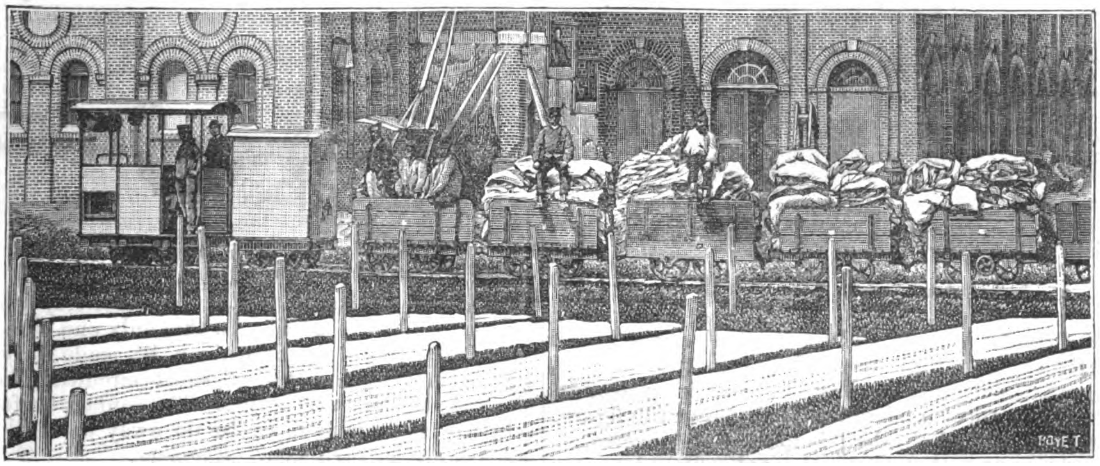

Fig. 4.—Showing the Loaded Train returning to the Factory.

* This rheostat chain was invented by M. E. Reynier, who applied it to a sewing machine which was shown last year at the Paris Electrical Exhibition.

West India and Panama Telegraph Company.—The estimated receipts of this company for the half month ended the 15th May amounted to £3,237, as compared with £2,766 in the corresponding period of 1881. The January receipts, estimated at £4,856, realised £5,039.

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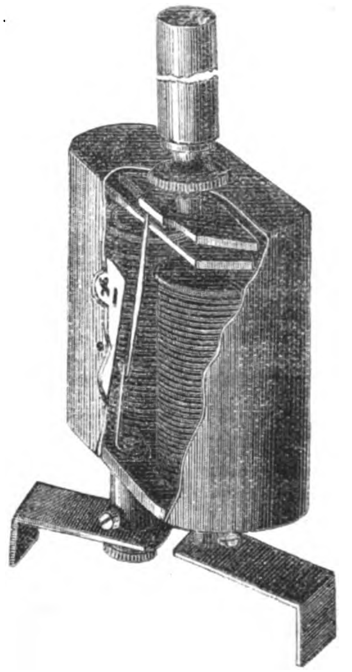
A BATTERY CURRENT TESTER.

The figure represents an apparatus which has been constructed by MM. Barbier and Pieret to enable battery cells to be readily tested, both as to whether they are giving off any current, and the character of the current. The apparatus is composed of a metal cylinder, which serves at the same time as a bell and a covering for the magnets, &c , inside. A handle at the upper part permits the two lower ears to be fitted to the poles of any cell that may be required to be tested. The electro-magnet in the interior attracts an armature, to which



A Battery Current Tester.

is fixed a small hammer which strikes the bell at the back; the interruption of the current is produced by the displacement of a small plate in the shape of a spring placed in the front of the apparatus, and which is shown in the figure. According as the sound of the bell is loud or the reverse, so the strength of the current can be estimated. The character of the current, whether positive or negative, is indicated by the appearance before a small hole in the cylinder of a steel plate with the + and − sign painted on it. This plate is so arranged as to be attracted by either magnet, and at the same time to cause the + or − sign, according to the character of the current, to appear.

BREWTNALL'S PATENT COUPLINGS FOR ELECTRICAL PURPOSES.

The accompanying engravings illustrate a new and simple coupling, invented and patented in England and abroad by

FIG.1

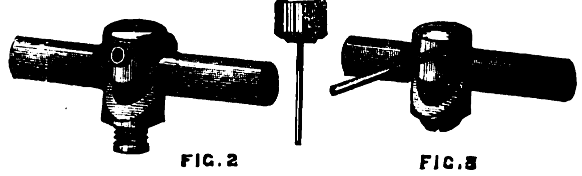
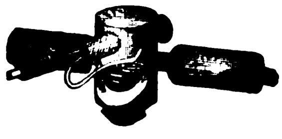


FIG.2 FIG.3

Mr. A. W. Brewtnall, for connecting branch wires with main electric light leads, which will be of especial use in fitting incandescent lamps. The couplings consist of a small brass cylinder, one end of which is solid, and the other fitted with a broad screw or nut, as shown in Figs. 1 and 3. A slot is cut in the side at an angle of about 45 deg. and long enough to receive the main wire or cable. Intersecting this a hole is drilled, either longitudinally or tranversely, to receive the branch wire. When the wires are put in their respective positions, and the screw or nut is tightened up, the main wire or cable is jammed forcibly against the branch wire and against the solid end of the slot. This gives a very firm and enduring contact between the two wires or conductors, and the surface contact is large, thus ensuring perfect electrical conductivity. A fusible portion can also very easily be combined with this form of connector, as shown in Fig. 4, which is an obvious advantage.

These couplings furnish a rapid, easy, and absolutely reliable means of connecting up wires, and entirely supersede the old method of soldering. No tool or material of any kind is required, save a screwdriver and the usual knife or instrument for cleaning the insulating matter off the wires. They

FIG. 4



are supplied at a very moderate cost by Messrs. Faraday and Son, Berners-street.

Fig. 5 shows a new form of ball-and-socket joint to be used

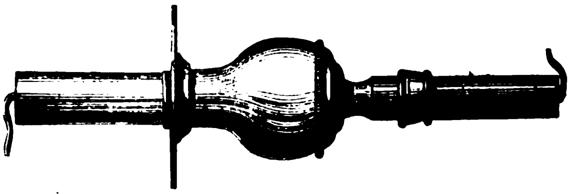


FIG. 5.

with electrical chandeliers, or "electroliers," also introduced by Mr. A. W. Brewtnall. In this only one wire need be used for the lead, and the return can be made through the outer tube without any chance of short circuiting, however much the "electrolier" may swing. The contact surfaces are large, and are so arranged as to do away with all possibility of "sparking" or corrosion.—*Engineer.*

THE CEYLON TELEGRAPH DEPARTMENT.

The greatly improved working of the local telegraphs has lately been the subject of general remark. This improvement is more especially realised by the press in the earlier receipt of Reuter's messages of public news. Up to a short time ago these daily messages seldom came to hand before 6 p.m.; but now a telegram delayed later than that hour is the exception rather than the rule. As a consequence we are able to pass our evening issue fully made up for the press by that time (6 o'clock), and the complaint about late delivery in town should be a thing of the past, if only Sinhalees delivery peons can be made to do their duty.

This is, however, by the way. We have been inquiring about the telegraph improvements, and learn from the director that the second (public) wire recently established between Colombo and Kandy enables the department to work with Paumben direct, almost throughout the day, and to avoid anything like serious delay in the exchange of messages with that station. On Wednesday last, for instance, the maxima and minima message traffic returns were:—

Minutes.	Minutes.	
88	41	Calcutta
130	43	Bombay
76	32	Kurrachee
36	10	Madras

For some time before the second wire came into use, the speed of working had been accelerated considerably, but the additional facility acquired when this second wire is hung between Matale

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and Mannar will entirely put a stop to delays in transit, and the Colombo public will then practically receive their messages almost immediately after the time at which they reach Paumben. At present the traffic of Jaffna, Mannar, Anuradhapura, and Trincomalee, with other stations, has to pass over the same line, so slightly hampering the through work with Paumben. This, as we have said, will shortly be removed. The reconstruction of the line from Colombo to Kandy being now finished, the new line of three wires between Kandy and Matale along the railroad is the work in hand, and this will be disposed of by the end of April. Colombo railway terminus and the Kandy station are now in direct communication by a special wire just hung for the convenience of the traffic manager in working his up country railway lines. Altogether there are now four lines between Colombo and Kandy, two public and two railway wires. There is also the wire between the Colombo breakwater and Mahara quarry. Between Colombo and Kalutara there are two wires, one for the railway, the public one being prolonged to Galle. The line to Kurunegala has been created in pursuance of the policy which has placed each seat of provincial administration in communication with the central Government, and it is now finished, and a public telegraph office will be opened at Polgahawela station and at Kurunegala in the course of this month.

Between Kandy, Gampola, and Nawalapitiya, double wires are, of course, hung—for public and railway use—and we have no doubt this duplicate system will be carried along the railway course to Nanuoya and Haputale, so giving public telegraph stations ere long at Hatton (and probably one at Wattewella), Talewekelle, Nanuoya, Haputale Pass with branch wire extensions doubtless to Haldumulla and Badulla, as well as to Nuwara Eliya from Nanuoya.. The single wire from Gampola at present passes through the Mountain Sanatarium to Badulla and Batticaloa. Colombo and Batticaloa and intermediate stations work direct through Kandy, and this line is only "broken" (interrupted) when Nawalapitiya has to receive or send a message.

Altogether we may congratulate the colony, at a time when a "dead-and-alive" system of routine marks so many of the departments of the present Government, on the activity and progress displayed in our telegraphs under Mr. Skinner's direction, well seconded by his able lieutenant, Mr. Hurley. The island lines are now all in good working order, well insulated, and the instruments used are giving satisfaction. We have no doubt that further improvements, such as the amalgamation of telegraph and post office at out-stations, so as to enable every central post-station to have a wire, will be in due time carried out. Wherever the railway goes, as we have said, the wire, both for department and public use, is bound to follow. The present district post offices will, doubtless, in many cases be removed to the railway stations and utilised for both post and telegraph. When the wire reaches Haputale, the only extension of importance that will remain for the Ceylon Government to carry out is one thence to Ratnapura and across through Rakwane to Matara and Galle so as to give duplicate communication. But now that the mail steamers are moved from Galle to Colombo, it is doubtful if this will be required, and Matara and the stations beyond (if the telegraph should be required by them), can well be served by an extension from the present Galle line.—*Ceylon Observer*, April 12.

THE TELEPHONE CASE.

After a long trial judgment has been delivered in this case. The plaintiffs were the United Telephone Company (Limited), and the defendants, Messrs. Harrison, Cox-Walker, and Co.

The judgment of Mr. Justice Fry was as follows :—In this case the evidence on both sides has been of great extent and interest, the instruments which are in controversy are of the highest ingenuity and value, and the questions that demand decision are of considerable perplexity and delicacy.

The plaintiff sues on two patents—of these, the first that I shall refer to as the Bell patent, was granted on the 9th of December, 1876; the second, which will be referred to as the Edison patent, was granted on the 30th July, 1877. The defendants have, as is admitted, made and sold three instruments which are in question; first, a receiver, known as the Cox-Walker receiver, which is alleged by the plaintiffs to be an infringement on the Bell patent; secondly, another receiver, the Hickley, likewise alleged to be an infringement of the Bell patent; and, thirdly, a transmitter known as the Hunning, alleged to be an invasion of the Edison patent. Long before the year 1876, in fact about fifty years ago, discoveries had been made by Faraday in electricity and the connected sciences, which undoubtedly lie at the bottom of the present inventions. The substance of those discoveries I take to be fairly stated in the specification to Bell's patent when he says :—"It has long been known that when a permanent magnet is caused to approach the pole of an electro-magnet a current of electricity is induced in the coils of the latter, and that when it is made to recede a current of opposite polarity to the first appears upon the wire. When, therefore, a permanent magnet is caused to vibrate in front of the pole of an electro-magnet an undulatory current of electricity is induced in the coils of the electro-magnet, the undulations of which correspond in rapidity of succession to the vibrations of the magnet, in polarity to the direction of its motion, and in intensity to the amplitude of its vibration, or, rather, to the velocity of its motion." That invention of Faraday was, as we know, one of the most pregnant of modern discoveries. It had long been known that a vibrating metal tongue or reed could be used to make and break the contact of a galvanic circuit, and thus produce an intermittency in the current, and that similar vibrations caused by the successive presence and absence of the magnetic attraction be reproduced in another metal tongue or free reed; and the idea soon suggested itself that if the first tongue were so vibrated as to produce sonorous undulations similar results could be produced at distant places wherever the current was carried. This was the principle of the musical telephones which existed before 1876, and which in certain cases were found, occasionally and uncertainly, to reproduce vocal sounds with musical ones, especially vowel sounds.

An inventor, the German Reis, had gone a step further and used a membrane to set a piece of metal in motion, but according to the evidence before me, it is clear that before Mr. Bell's discovery there was no practical and trustworthy mode of transmitting articulate sounds to a distance by means of electricity. Mr. Bell appears to me to have seized three ideas. In the first place he distinctly perceived that whilst for musical notes the tongue or free reed might act both as transmitter and as receiver, for the human voice you must employ an extended and elastic surface, such as a disc of metal or a membrane extended and attached to a circumference, after the fashion of the drum of the human ear; and, secondly, that whilst for musical notes intermittent currents might be used, the undulations of the human voice could be communicated only by continuously undulatory currents; thirdly, that it is not necessary for the purpose of communicating the human voice to use a battery current, but that an undulatory current adequate to this purpose may be produced by placing two permanent magnets surrounded by coils, one in the transmitter and the other in the receiver, and operating on one of these by the vibrations of a plate of inductive properties placed within the magnetic field. This vibratory action of the plate produces the undulatory current which operates through the permanent magnet of a receiver on another plate of inductive properties placed within its field.

In or before the end of 1876 Mr. Bell had made an instrument which, in the first place, appears to have had a transmitter and receiver of the same character, each of those instruments consisting of a tympan or drum of membrane, which tympan or drum carried a piece of iron at an armature capable of producing inductive action; the receiver appears to have been constituted in the same way, and he appears, in the first place, to have used an instrument of that construction; but in August, 1876, at the Exhibition at Philadelphia, he exhibited an instrument made after a somewhat different fashion, in that the transmitter consisted of a membrane charged with an armature, a piece of steel spring, but the receiver was an annular magnet, furnished with a flat plate by way of armature—the external circuit, the annulus, in fact, of the magnet being one of the poles, and the central core being the other pole; and it appears to me to be clear as exhibited at Philadelphia that the armature was not attached in any way, in any physical or mechanical manner, to the body of the receiver, but that it was held down by the force of the galvanic current which passed through that receiver. Sir William Thomson visited the exhibition at Philadelphia, and naturally attended with the utmost interest to the instrument there exhibited by Mr. Bell. It appears to have answered to a certain extent in Sir William's presence, and he undoubtedly heard words brought from a distant room to that receiver. The discovery, of course, was one of the greatest interest to him, and when he was leaving Boston Mr. Bell placed in his hands a brown paper parcel which contained a transmitter and a receiver, which has been produced in Court, and which have been the subject of a vast amount of discussion. When Sir William Thomson opened that parcel he found that the armature of the receiver was attached to the annulus of the magnet by a screw, and, according to the conclusion which I arrive at, on the evidence, he found the armature tilted at a certain angle from the plane of the top of the receiver.

Sir William Thomson brought these instruments with him to this country, and at the meeting of the British Association which took place in September of that year at Glasgow he exhibited those instruments, and made them the subject of a portion of his address as the vice-president of one of the sections. The words of his discourse have been in evidence before me; they contain a statement of the results which have been arrived at by Mr. Graham Bell, but do not in my judgment communicate to the public the exact method by which those results were arrived at. It will be necessary for me hereafter, considering the objections made to the patent, to consider more in detail the fact of Sir William Thomson's exhibition of those instruments in Glasgow. I mention them now merely as part of the narrative of the case. On the 9th of December, 1876, the letters patent which are first in question were granted to Mr. Morgan-Brown on the communication made by Mr. Bell to him, and those letters patent were the subject of a disclaimer and memorandum of alteration which was filed, I think, on the 13th of February, 1878. The specification as originally filed contained five or six distinct plans of operation; with regard to the first three it is not necessary for me now to say anything more than to observe that they related to what has been called multifold telegraphy, and that they provided for the transmission of several currents along one wire or system of wires. They are not retained in the disclaimed patent except so far as they are necessary to the explanation of the fourth and fifth plans there contained. Speaking briefly, the fourth plan mentioned in that specification provides for the transmission of the human voice, by means of a continuous voltaic current; it provides for a transmitter with a membranous tympanum and a conductive armature; it provides for a similar receiver, and it also adds as an alternative plan the use of metal plates or other conductive substances. The fifth plan is founded on the discovery which I have already mentioned as having been made by Mr. Bell—in that plan the battery is omitted, and the permanent magnets are substituted for the electro-magnets in the last plan, and the current produced by the vibrations is not superimposed upon

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a voltaic current, but is itself used to create corresponding vibrations in the receiver. A subordinate feature is also described which is really a description only of an electric equivalent in that form. In place of the permanent magnet you find electro-magnets in a secondary or electrical circuit, and not therefore operating upon the generodes in the main current as in the fourth plan—those two plans which form the fifth are in fact for electrical purposes one and the same. It is impossible to doubt the beauty, or the value, or the ingenuity of the discovery that had been so made by Mr. Bell—he had solved one of the most difficult problems of physics, one which undoubtedly had been attracting the attention of men of science for many years past. It was, however, found that the membrane used in the tympan was not entirely successful; in the first place that membrane had, as I have already observed, attached to it an armature—a piece of steel wire—and the presence of that weight at a particular portion of the tympan seems, according to the evidence before me, to have had some disturbing influence upon the action of the tympan itself. Furthermore, the membrane is liable to be influenced by changes of atmosphere and by the difference of moisture in the atmosphere, and was much as the receiver might be at a considerable distance from the transmitter. It is obvious that different atmospheric influences might operate on the two instruments, and therefore place them not in harmony, but in discord. Those difficulties in the way of the use of the membrane induced Mr. Bell, in the memorandum of alterations to which I have already referred, to point out that a great improvement had to be introduced into the instrument by substituting for the membranous tympan a metal plate or metal disc, which, of course, was inductive in its own nature, and was free from the objections which were found to obtain in the case of the membrane. That, as a whole, the instrument disclosed by the letters patent was new appears to me not to be doubted. What had been done only occasionally and ill before by such instruments as those of Reis, which has happened to communicate speech by intermittent currents; what Sir William Thomson himself could not do with the Glasgow transmitter and receiver—because although anxious to exhibit that instrument to the British Association at Glasgow, he had been unable then to show that it could work—what Dr. Muirhead, a witness before me in the course of this trial, could not do in his attempt to copy Sir William Thomson's instrument, that could be done as soon as the complete specification was made known. That the Glasgow instrument, taken as a whole, was incapable of producing this satisfactory result is proved to me by the fact that it failed in the hands of perhaps the most skilful person in the world to deal with such an instrument—Sir William Thomson himself.

It remains, however, to inquire whether the other instrument alone is claimed, or if not, what parts were claimed, and whether the parts so claimed were new, and whether the invention had been infringed by the defendants.

The defendants have used and sold instruments known as the Cox-Walker and Hickley receivers, and no argument has been addressed to me to show that they are not in substance the same as the Bell receiver; but the difficulty which the defendants present to the plaintiffs' case takes the form of an alternative argument. If, say the defendants, you claim only the receiver in combination with a transmitter like Bell's, we have not infringed, for we have never used such a receiver; if, on the other hand, you claim the Bell receiver as a substantive and independent invention then it is not a new one. There is no evidence of the user of the Cox-Walker or Hickley receiver, with an instrument like the Bell transmitter, and, in fact, it does not appear to have been so used. That Bell's specification claims the receiver he there describes as a substantive invention is the common case both of plaintiffs and defendants, and is also in accordance with my own construction of the specification. Has Bell's receiver, then, been anticipated by previous inventions or by public knowledge? Before considering the anticipations, I think it expedient to describe Bell's receiver as claimed by him, and as I understand it, it consists of a horse-shoe magnet, the ends of which are brought into the circuit by means of coils of wire, and in front of which is a metallic plate, capable of inductive action, placed at right angles to the length of the magnet, resting as regards its circumference on the wooden case. The vibrations in this plate are the source of sound in the receiver. In Bell's instrument the receiving and transmitting instruments are interchangeable, and the fourth and fifth plans both, in my judgment, describe an apparatus in which there are such instruments as I have described used for both these purposes.

The anticipations relied on are the first and second instruments made by Reis, or described by Reis, and the publication of Bell's own earlier plans through Sir William Thomson. Now, with regard to the instrument which has been called the first Reis, it appears to me to be made out plainly in the evidence that it was known in this country before the patent was taken out, but there is no pretence of a plate armature being used in that instrument. The machine depends for its operation on the repeated making and breaking of the currents, and upon the fact that the rod of iron included in the coil of the receiver gives a distinct tick each time it is demagnetised. The repetition of these ticks is made to produce the vocal sound. The essential parts, therefore, it appears to me, of the Bell receiver, are not in any way to be found in the receiver of the first Reis.

With regard to the second Reis, which is the instrument described in Mr. Legat's paper, in the "Zeitschrift" of the German and Austrian Telegraph Union, two questions arise. The first is, was it so published as to be part of the public knowledge on this subject before the taking out of Mr. Bell's patent? The only book in which an account of this is said to have been published is the "Zeitschrift," to which I have already referred, which is, of course, in the German language. It contains, however, two plates, the one describing the transmitter, and the other receiver, and I think it would be difficult for a person looking at those plates, and having any knowledge of magnetic or electric science, not to come tolerably clearly to a conclusion as to what the object of the instrument was. It appears that the book was deposited in the usual manner in the Library of the Patent-office, and also in the Library of the Institute of Civil Engineers; but in the latter case it was catalogued as a journal, and, somewhat strangely as it appears to me, was not catalogued either under the head of electricity or magnetism, or any kindred subject; but it is to be borne in mind that this paper is to be found, not in some scientific journal, not mixed up with other papers on other subjects, but it is in the journal of a society devoted to telegraphic purposes, the existence of which, I should think, can hardly be unknown to persons skilled in such matters in this country, and where it seems to me very natural that anybody would search for information, as, in fact, Dr. Muirhead did search for it, and to some extent found it. It is true that the only person who is shown to have consulted it in this country is Dr. Muirhead, who, though unable to read German, was enabled by his knowledge of the technical terms to spell out some information from the paper.

Upon the whole, though not without some doubt, I have come to the conclusion that there is evidence before me upon which I infer that the communication made by Legat in that journal must be considered to have been within the knowledge of persons skilled in these matters in this country; it appears to me that that is the fair inference from the facts proved before me. I need not say in coming to that conclusion I have endeavoured to attend to all the earlier decisions, including the decision of the Court of Appeal upon the Patent Skate case; and I think that the conclusion which I have already expressed is consistent with those decisions; though I am bound to admit that different minds might, as a matter of fact, come to different conclusion on the matter. Assuming then that the second Reis, as described by Legat, was a matter of public knowledge, it remains to consider whether the instrument as there described was an anticipation of the receiver as patented by Mr. Bell. In my judgment it was not. Looking at the plates it appears to me to be plain that the armature in Reis's receiver was not a disc at all, it was not a plate at all, but that it was a beam, a solid bar—when I say solid, I do not mean that it was rectangular; it appears to me to have been a bar whose section was oval—and that is the result which is conveyed to my mind by the plate, and I think that the model which has been exhibited before me in which that bar is converted into a twisted or curved disc does not really and truly represent the instrument as described by Reis. I think, therefore, that the criticisms of Sir Frederick Bramwell on that model were perfectly well founded, and that there was nothing in the Reis which can be considered to have been an anticipation of the armature of the description indicated in Bell's patent. No doubt Reis's invention is coming near to the invention which was afterwards made by Mr. Bell, but it appears to me not to be the same; and I am not at all convinced that it will operate in the same way. It is perfectly true there is some evidence before me that Reis's instrument will speak, but it does not appear to me that there is any evidence which shows that it could be made successfully to speak before Mr. Bell's patent was made known; and it is obvious that the advances which have been made in telephonic science, very largely in consequence of his discoveries, have enabled persons to use instruments in a manner which neither their inventors nor their users could have used them before the discovery, and I think this must be further borne in mind, that instruments as little like the true Reis as the ones that have been exhibited would, I have no doubt, apply within the description of Reis's instrument as being universal instruments. I next approach the inquiry whether the disclosure which has been made through Sir William Thomson, and through the various scientific papers which copied or examined this instrument before December, 1876, the Glasgow receiver, made the principle of the Bell receiver which was afterwards patented a portion of the public knowledge. As I have already mentioned, Sir William Thomson explained during his discourse at Glasgow—both the transmitter and the receiver—they were not in action; they do not appear to have been connected, and no experiment was performed or at that time could be performed by Sir William Thomson to explain their action, because, as I have already said, he had attempted to make them speak, and he had failed. Both instruments, as I gather, were on exhibition some time afterwards, at first apparently in the room in which the lecture had been delivered, and at a subsequent date in the laboratory of the Glasgow University, which was open to everybody interested in the subject; and there is evidence before me from which one would infer they were the objects of continual curiosity to persons interested in this class of discovery. Professor Barrett saw them there, and made drawings, which he exhibited to his class at some date or other; and Dr. Muirhead made a rough sketch. The announcement of Sir William Thomson was communicated to Mr. Ayrton, who at that time was thousands of miles off, and a description of it appeared in the *Telegraphic Journal* of October, 1876; every person one may suppose, who is interested in such things, probably within the four corners of the world soon became aware of the discovery which had been announced by Sir William Thomson.

That the Glasgow receiver can now be made to speak, though not very distinctly, I know from what has taken place in this court, because I have heard it; but I do not forget that the utterances which I heard were the result of applying to this receiver a great amount of galvanic energy, and a transmitter, which, so far as I can learn, was of a perfectly exceptional character, a Hunning furnished with seven separate cells; further, I have no evidence that any one made the Glasgow receiver speak before the publication of Bell's invention. There is no doubt that, as exhibited at Glasgow, the armature was fitted on by a screw and with a tilt, and there can also be no doubt that some of the most competent and skilled persons who saw it, like Sir William Thomson himself, came to the conclusion that the disc was intended to be so used, and that the tilt was part of the design and intended structure of the instrument, and that is not wonderful when one bears in mind the fact that down to this time almost all the experiments which had been made, or instruments which had been formed for the purpose of transmitting speech, had used an instrument in the nature of a free reed or tongue, and that this disc so fastened on had, therefore, the position of a free reed or tongue—it might be operated upon by the galvanic attraction of the circles of the receiver. There were others who saw the instrument, and who came to the opposite conclusion; but I have before me evidence which shows that Mr. Dunscombe, an instrument maker, who was instructed to make a copy of it from a photograph or from an engraving published of the Glasgow receiver, made it purposely with the tilt. In this conflict of evidence I have come to the conclusion that it was far from plain that the tilt of the disc was not an intentional part of the structure. The effect of this tilt on the action of the disc is great; it makes it act, as regards its vibrations, partly as a tympanum and partly as a free reed. As the armature appeared at Glasgow it was, in fact, intermediate between the old form of armature, the free reed, and the latter form of Bell in which the flat disc was used. The Glasgow instrument differed in other particulars from the Bell receiver; in the Bell the magnet was wholly within the case, and the circumference of the disc rested on the wood, and was held down by the wood; in the Glasgow receiver the magnet was annular, the circumference of the instrument being one pole and the interior core the other,

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and the disc when held down at all was held down by the magnetic attraction, a form which requires, as I think, a much greater exertion of galvanic force than the mere adoption of a disc mechanically kept in front of the magnet; lastly, the Bell receiver is capable of being used as a transmitter, a quality which does not belong to the Glasgow receiver. These differences may appear to be small, but small diversities in delicate matters often make the whole difference between success and failure; and in the present case I have the distinct testimony of Sir William Thomson and others that the Bell receiver is superior to the Glasgow receiver, and my own experiments with the Glasgow receiver, even under the most favourable circumstance, lead me to the same conclusion. I do not forget Professor Silvanus Thompson's Bristol receiver—I did not at first hear well through it, but subsequently I heard better, but I think that that has been worked with a less tilt than as it was originally made, or than the Glasgow receiver possessed; and with the whole light cast upon the best mode of user by discoveries subsequent to 1876—that instrument I may observe was only made in the beginning of the present year. With the single exception of this Bristol receiver, and another instrument very similar in form, but having a thinner armature, and a rough and unsuccessful copy of the Glasgow receiver attempted by Dr. Muirhead, I find no case of the Glasgow form of receiver even having been used. The burden being on the defendants to show that the anticipation of the Bell receiver by the Glasgow receiver was by an instrument practically as good as the patented one and of an invention which had passed beyond the stage of mere experiment, I think that they fail in discharging that burden.

There remain two other objections to be considered—the first of those depends upon the first clause made in the specification as amended by the disclaimer. That claim is in these words:—"The combination substantially as set forth and described respectively in the fourth and fifth plans above referred to, but subject always to the disclaiming notes of a permanent magnet, or other body capable of inductive action with a closed circuit, so that the vibration of the one shall occasion electrical undulations in the other or in itself, and this I claim whether the permanent magnet be set in vibration in the neighbourhood of the conducting wire forming the circuit, or whether the conducting wire be set in vibration in the neighbourhood of the permanent, or whether the conducting wire and the permanent magnet both simultaneously be set in vibration in each other's neighbourhood." This claim is said to be a claim to undulatory currents pure and simple; that is, to the combination of a vibrating magnet with a current, all of which was well known to Faraday. To accomplish Mr. Bell's object four points of correspondence or identity are necessary. In the first place, the vibrations of the transmitting magnet must correspond to the vibrations produced by the voice; in the second place, the undulations of the electric current must correspond to the vibrations of the transmitting magnet; in the third place, the vibrations of the receiving magnet must correspond with the undulations of the current; and, in the fourth place, the audible vibrations in the air must correspond with the vibrations of the receiving magnet. If all these correspond, the desired result is produced. Mr. Bell's real stages were the first and the last, the bringing together of the vibrations in the air and of the two magnets at the two ends of the operation, the unification so to speak of the diaphragm and of the magnets—but the first claim, so runs the argument, is to the correspondence of the vibrations of the transmitting magnet with the undulations of the current, a thing as old as Faraday, and hence the patent is void. But the patentee himself has shown his consciousness of what his old knowledge was, because in the passages which I read he explains, as it seems to me, with reasonable clearness, that the correspondence between the vibrations of the magnet and the undulations of the current was a thing well known of old. To read the first claim therefore as one to Faraday's invention would be to make the document inconsistent with itself, and I think that the words "substantially as set forth" in the fourth and fifth plans introduced into this claim must be taken to confine the claim to the application of Faraday's principles to cases where the agitating magnet or inductive substance is itself agitated by the voice. I have already expressed my opinion that Mr. Bell was the author of a very remarkable discovery. I think, furthermore, that he has endeavoured honestly to describe that discovery in his specification, and where these two things are found, I think it is the duty of a judge to give, if needful, benign interpretation to the words of the document.

Lastly, it is objected that by his original specification Mr. Bell claimed to use for his disc or plate either membrane or steel or any inductive substance, and that by his disclaimer and memorandum of amendment he finds steel to be preferable, and claims not any inductive substance, but any equivalent plate capable of inductive action. I am unable to see in this change anything that can affect the validity of the patent. I think the description of the subject matter of the plate is adequate, and that the plate as described must be inductive, and equivalent to a steel plate as regards its capacity to vibrate with the voice. When those qualities are found it seems to come within the description contained in the amended specification. Those being the objections made to Bell's patent they all in my opinion fail, and I think that therefore the plaintiffs are entitled to an injunction to restrain the sale of the two receivers which are alleged to be violations and infringements of that patent.

I now approach the second part of the case which deals with Mr. Edison's patent. If a portion of the circuit consists of substances the parts of which are capable of being brought near to one another by pressure, the effect of the pressure will be that the resistance of the circuit will be diminished and the current will be increased. The most important part of Mr. Edison's invention consists in using the principle to produce undulations representing the voice by means of a plate actuated by the voice and causing pressure on the circuit, and according to the view of the plaintiffs' witnesses and of Professor Dolbear it is requisite for the practical success of this plan that there should be used a material of low conductivity. It is further requisite that it should possess, either in itself or in the mechanism by which it is supported, sufficient resiliency to revert to the condition in which it existed before the pressure was exerted. This device was called by Mr. Edison a tension regulator. The principle involved was not new; the law that the current of a given battery varied inversely with the sum of the resistance of the circuit was old and familiar to electricians; and the fact that resistance was capable in certain cases of being diminished by pressure was known as regards certain materials, though the effect of pressure on the resistance of metals and any other substances was at the date of the patent an obscure subject, and appears to be still far from expostulation. Wherever the metallic point had constituted part of a circuit, and had been subject to any pressure, inasmuch as all metals have some elasticity, there had been, in theory, a tension regulator, because the resistance lessened as the faces of the metal points broadened. Such a tension regulator as Mr. Edison invented has been discovered in Reis's instrument. Again in Clerac's tube, carbon in some form or other had been subjected to pressure in order to lessen the resistance to the current; but there the result was produced by screws, and was not varied automatically in proportion to any other force. In Mr. Bell's patent of 1876 the production of electrical undulations, by alternately increasing and diminishing the resistance of the circuit, had been explained, but the mode for use had the electrodes in water, the mode of action of which was limited, to a certain extent, by reason of the generation of gases from the electrical decomposition of the water. Another similar invention appears to have been made by Mr. Gray, but its precise nature has not been disclosed to me, and nothing has been produced to affect my conclusion that Mr. Edison, by putting a plate, actuated by the human voice, of a substance capable of having its resistance diminished by compression and requiring resiliency, had a novel and brilliant discovery of course associated with it. Mr Edison's patent bears date the 30th of July, 1877; the specification was filed on the 30th of January in the following year, 1878. Two disclaimers and memoranda of alterations have been filed, one of the 10th of February, 1880, and the other on the 13th of June, 1881, and by those memoranda very great alterations have been made in Edison's original claim.

It now becomes necessary to consider the specification of Mr. Edison, and the question which is so closely connected with it, as to whether the Hunning transmitter is an infringement of the specification. On referring to the specification, as amended by the disclaiming notes, it will be found that Mr. Edison uses this language: "This invention relates to that class of electrical instruments in which sound becomes one of the elements in the transmission of the communication, and a corresponding sound is produced at the receiving station, so that oral communications can be sent by electricity, and clearly distinguished at the receiving station. Musical tones may also be sent, but my present invention is especially available in transmitting and receiving oral communications. In transmitting musical tones the respective notes each have a definite period for each vibration, hence there is a response at the receiving end from the notes that vibrate in time with the electric pulsations sent, but in speaking there is little change in the musical tone, but considerable in the modulations and inflections of the voice. In my present invention I make use of the vibrations given to a diaphragm or tympan." I pause there to make this observation, that, in considering this specification, two questions principally require decision—the first is as to the nature of the diaphragm or tympan referred to in the specification; the second is as to the matter of the tension regulator, and what parts necessarily go to make up that tension regulator, as substantially described in the specification. Now, before reading further, I will make this observation: that it appears to me that the words diaphragm or tympan ought to receive their ordinary signification in this specification, unless there is anything to show the contrary. The ordinary signification of the word diaphragm I take to be a mere partition or separation—something which, as one witness said, separates something from something else. It is, perhaps, most often applied to a separation existing in that which but for the separation would be one continuous cavity; but it is not in my judgment necessarily confined to that use. A tympanum, or, as the word is used in the specification, tympan, signifies in my judgment primarily a thing like a drumhead—a thing in which a substance elastic in itself, but not acting as an elastic substance unless strained, is strained over its circumference and acts in the manner of a drumhead. Now it will be observed throughout this specification that what Mr. Edison refers to is a diaphragm or tympan. I say that, not forgetting that in some cases he uses the one word, and in some cases the other, and according to the conclusion which I have arrived at, which I will now state, in order that it will make more plain the meaning of the specification, I think that the quality which he required in his diaphragm is plainly expressed in the specification, namely, that it shall vibrate with the voice. It has been urged upon me that a tympan possesses another quality, that of magnifying the vibrations produced by the voice. It is quite true that a tympan does possess that quality, but it is equally true that a diaphragm by no means necessarily possesses that quality, and it appears to me that using the words interchangeably and describing the quality that they must possess, that of repeating vibrations, it would be wrong to require in everything which is to come within the ambit of this specification a quality not belonging to a diaphragm, and not expressed or referred to in the specification as being essential to its operation. Making those observations, I now return to the reading of the specification. "In my present invention I make use of the vibrations given to a diaphragm or tympan, by speaking into a resonant case, to produce a rise or fall of electrical tension upon the line with such accuracy that the electric pulsations or waves will represent the atmospheric sound waves produced by articulation, and the electro-magnet at the receiving station will respond to the electric waves in such a manner as to reproduce articulation by acting upon a resonant plate." There I find that the diaphragm, or tympan, whichever it is, is to be something which will vibrate, and which by its vibrations will give rise to the rise and fall of the electric current, nothing more. Then referring to the pictures or diagrams he says, "The resonant tube or box *a* is of a size and shape adapted to being spoken into, the same having an opening at one end or side, and a diaphragm or diaphragms *b*, against which the sound waves from the human voice act, and these and the motion that the diaphragm receiver is the means of producing a rise and fall of electric tension on the line by the devices hereafter set forth." Now, there again I find that what he aims at is a diaphragm vibrating with the sound waves, nothing more, which by its pressure on the substance below operates on the electric current. Then he says—"The general features thus described pervade my entire invention." We have therefore arrived at the general statement of his invention. Then he proceeds—"But in developing the same many useful and important modifications and variations have been made, which I will proceed to set forth." Then, after making some remarks, which it is not necessary for me to read, and referring to the difficulty he had experienced in producing hissing consonants, and to the form of the box which is intended to get over that difficulty, he says:—"The next feature requiring consideration

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is the character of the diaphragm in the speaking instrument. Many materials have been employed by me, such as metals, horn, vellum, celluloid, ivory, &c.; but almost all of these produced a prolonged or secondary vibration from their own resonant character, hence the articulation is defective, and the sound vibrations blend. After extensive experiments, I find that mica is almost entirely free from any resonant action, and hence it will respond with the greatest accuracy to the sound vibrations, and being of a laminated character can be employed of any desired thickness, and when secured at its edges responds with the greatest accuracy to the sound vibrations, and does not require to be strained; furthermore, the changes of temperature and atmospheric condition have little or no effect upon the mica diaphragm or tympan." I only pause to observe here that it is plain that the mica structure is not, properly speaking, a tympanum, because it is not strained, and that he therefore shows that what he prefers above all others is that which is more properly described as a diaphragm and not as a tympanum—of course, I do not forget it has a certain operation as a tympanum; but what I mean is that the mica not being strained is not within any conception of a tympanum, as usually described. Then he says, "I find it is not practical to open and close the line circuit in instruments for transmitting the human voice, the circuit to the line must be always closed, and the transmission be produced by a rise and fall of electric tension, resulting from more or less resistance in the line. This resistance may be produced in several ways." Now we approach his description of the tension regulator. "I have shown several which will hereafter be named, but I find the most delicate to be small bunches or tufts, or discs of semi-conducting elastic fibre such as particles of silk, and an intermediate conducting or semi-conducting material. This device I call an electric tension regulator; it is more or less compressed according to the vibrations of the diaphragm or tympan, and the electric current rises in tension as it is compressed or lessens as the fibre expands." Then he proceeds to describe more in detail the application of this particular electric tension regulator, and he says:—"The fibre is rendered semi-conductive by being rubbed with plumbago, soft metal, or similar material, or by a deposit of metal upon its surface, or by fine particles of conducting or semi-conducting material mixed with it, that conducting power varying with the density of tuft or bunch of fibre." That tension regulator, consisting of the silk with the metallic coating or other substance put over it, is the one which is described in greatest detail by Mr. Edison; but many other forms of tension are described, and those, it appears to me, may be classified in this way. I find a tension regulator constituted of semi-conductive substance with inherent resiliency, such as the one I have already described. I find others which are to be constituted of a semi-conductive substance with an artificial resiliency, that is, a resiliency gained by a spring or other mechanism by which it is applied. I find others in which the operation proceeds on a different principle, they depend on circuiting, as it is called; that is to say, on diminishing the distance through which the electric current has to travel. And those, again, are of two kinds; there is one the operation of which is a little complicated, operating by a spring, and there is another in which the electrodes are inserted in water—the electrodes by pressure from above approaching other electrodes below, therefore diminishing the water space between the two—and, lastly, there is a very complicated arrangement with a rheostat, the short effect of which I conceive to be that a current which in its nature but for the rheostat would have been intermittent is converted into a continuous current, the rheostat operating for a sufficient time to prevent the current ever entirely ceasing, and in that way a continuous but undulatory current is produced.

The claim made in respect of these tension regulators is this:—"In an instrument for transmitting electric impulses by sound, a diaphragm or tympan of mica, substantially as set forth." I have already expressed my opinion that the words diaphragm or tympan must be taken to be used in their natural sense—anything which separates the substance below from the air or the substance above would be a diaphragm, anything which is stretched in the nature of a drumhead would be a tympan, and both those according to the description must be capable of being vibrated by the voice, and if they are that, they are diaphragms or tympans within the meaning of the words as used in the specification.

There remains to consider what is the meaning of "the tension regulator substantially as hereinbefore described." It appears to me plain that the patentee did not intend, and the specification does not intend, to confine them to the particular forms of tension regulator which have been indicated. The description of the first form, as I have already observed, is the most minute; I find as requisite, first, the quality that with its compression the resistance shall be lessened and the current shall be increased. There is probably a quality present, more or less, in all cases in which the substance through which the current passes is broken into pieces. The resistance lessens as the interspaces increase, and *vice versâ*. Secondly, I find that its substance must either from its inherent character, or from its composition as a whole, be of a semi-conductive character; the material must not be an absolute non-conductor, for that would destroy the current; it should not be a good conductor, for then the interruption would probably bear so small a proportion to the current as not adequately to influence the stream, or create sufficient undulations in the result. Accordingly the evidence satisfies me that, though theoretically high conductors could be used as tension regulators, and though such substances had been occasionally used with success, yet practically, and especially with a view to the uniformity of results, semi-conductors are best. It is said that this result is due to the fact that in high conductors the point of fusion is low, so that the pieces get fused together; but as it appears that all the high conductors are easily fusible, and the semi-conductors are not so, the distinction drawn was sufficient for practical purposes. Thirdly, I find the material must have had such a resiliency as will enable it on the withdrawal of the pressure to return to its previous condition, and thus affect the current which had been increased by the pressure, and be ready again to yield to pressure and again to recover its old position. The necessity of such a quality I find expressed not only in the description of the silk, in the first part, as an elastic fibre, and in the various contrivances to produce an artificial resiliency, but in the general description of the nature of the instrument which requires such a recuperative elasticity if it is to act on more than one single occasion. Accordingly I find that in the various forms of tension regulator indicated in the letters patent this resiliency is acquired, though in various ways; in some by the inherent elasticity of the substance, the silk or cork; in some by the elasticity, as in the cases where plumbago points are used by means of springs; in some as in the lamp-black, and in the coke by the pressure of the elastic gases in the interstices of the material. I think, therefore, that the true meaning of the claim which I have just read is the union of a tympan or diaphragm capable of vibrating under the sound waves with an electric tension regulator having the quality which I have just described, because that appears to me to be an electric tension regulator substantially hereinbefore described.

I now approach the question which is very intimately connected with the consideration of the specification—Is Hunning's transmitter an infringement of Edison's transmitter? In Edison's transmitter we find, first, a diaphragm or tympan, or plate, which receives the sound of the voice. Below that there is a cork, not of the same size as the diaphragm, placed in the centre, and of a smaller area. Below that comes a piece of platina foil, which is the same size as the cork, and corresponds with the size of the cavity in which the tension regulating substance is placed, in which is one of the electrodes in the current. Below that comes the lamp-black or other substance which is used for the purpose of the tension regulator, and below that comes the bottom of the box, which is itself the electrode, in which is placed a screw for the purpose of initial regulation. The Hunning transmitter is different in this way—that it has no diaphragm or cork separate from or other than the platinum foil. The platinum foil in Hunning's receives directly the human voice. They are of the same character, in there being a cavity or cell in which the metal bottom is one electrode, and the platinum foil at the top the other, but the differences are, I believe, to be fairly stated as follows:—First, the materials in the cell are different; coke has been used by Hunning, lamp-black has been preferentially used by Edison. Coke is not mentioned with any of the articles used in Edison's specification. In the next place the size of the particles is different, the particles of lamp-black being, in fact, very much smaller than the particles into which the coke is crushed. In the next place, as I have already pointed out, there is in Edison's the superimposition over the platinum of cork and disc; and, lastly, there is the screw at the bottom which is applied in the Edison for the purpose of giving initial pressure, and there is a certain amount of difference in their action. In Hunning's the up-and-down motion produced by the voice is communicated through the foil to the particles directly; in Edison's, the up-and-down motion of the voice is translated into circular nodel ripples in the disc or tympan; this is re-translated, so to speak, to the centre, into an up-and-down motion which is communicated to the cork, and which the cork communicates to the foil, and the foil to the air. The result appears to me to be that that action in Hunning's is more accurate because more direct; in Hunning's case there is not that magnifying of the operation of the voice that takes place in the presence of the tympan or disc in Edison's. The Hunning transmitter appears to me, therefore, to be an improvement on Edison's patent, but it may none the less be an infringement of it, and I have come to the conclusion that, like Edison's, it is the combination of a diaphragm, vibrating with the voice, that being the platinum foil, with a tension regulator consisting of a semi-conductive resilient and compressible substance, and it is therefore within the scope of Edison's specification.

It has been argued that Hunning's transmitter acts on a different principle to Edison's, that the one demands compression and the other freedom of motion; that in the one the presence of a diaphragm is essential, and that in the other it is not—but the evidence, amongst others, of Professor Dolbear, shows that the presence of the foil is essential or useful in both cases. In both cases it acts as an electrode, in both it requires extension in order that an electric current may pass through all parts of the substance which constitute the tension regulator; in both it keeps the enclosed substances in their places. Before passing from this subject, and, considering the meaning of the word diaphragm, I think it not immaterial to observe that Mr. Hunning, acting with the assistance of the patent agent, whose name he mentioned to us, in describing his own invention, described the top of the platinum foil as a vibrating diaphragm. That is exactly the conclusion which I have drawn—that the platinum foil is a vibrating diaphragm, and I have concluded that Edison described as the essential requisite of his invention the combination of a vibrating diaphragm with a tension regulator.

The discovery Professor Hughes made in 1878, that the vibrations produced by the voice might operate on a heap of particles directly and without the intervention of any diaphragm or tympan, or any such thing, has in my opinion suggested the argument that Hunning's and Edison's transmitters operate on different principles; but not only is it the fact that the Hunning transmitter is not used without the platinum foil, but it has not been shown that it can be so used with success, and, according to the evidence of Professor Silvanus Thompson, the same physical principle, namely, that of diminishing the resistance and increasing the current by the increase of contact from pressure, underlies the light of the tension regulator of Edison and the microphone of Hughes.

I now come to consider the two objections which have been made to the validity of Edison's patent on the ground of the nature of the claims. The first of those is based upon the first claim, which is in these words "in an instrument for transmitting electric impulses by sound." If it did, it appears to me that the claim would be bad, because I think it is really the claim of the application of an old substance to a particular purpose without the use of any ingenuity in that application, without the use of any invention in that application; but if it means that the mica diaphragm is claimed in an instrument for transmitting electric impulses by sound, which is described in the specification, then I think that it is not in any way bad, and upon the whole I have come to the conclusion that it may be read as relating only to the mica diaphragm in combination with the rest of the instrument. It is to be borne in mind that in construing claims one must construe them not as enlarging the operation of the description, but rather as disclaiming everything which is not claimed. They are inserted for the purpose of drawing the line between what the patentee knows to be old and what he desires to claim as new in the invention he has described.

I now come, however, to the last and very serious objection to the validity of the patent. It is this—Mr. Edison discovered an instrument of the highest ingenuity, which is commonly called the phonograph. That instrument is a purely mechanical one, it has nothing whatever to do with electrical or magnetic science, it has nothing necessarily to do with the

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transmission of sound to a distance, it is in substance a diaphragm actuated by the voice, which operates upon a style, which impresses itself on an impressible plate. The impression which is made on that plate again actuates a style, which again actuates a diaphragm, which again actuates the air—that which is operating the one diaphragm in the form of human voices is reproduced on the other diaphragm in the condition of audible sounds. Mr. Edison points out in his specification that the voice can thus be produced by the second diaphragm. He also points out that the instrument may be used in another mode, namely, by connecting the second diaphragm with a transmitter, and using that diaphragm as the diaphragm of the transmitting instrument, in which case the second diaphragm not immediately produces an audible sound, but produces an undulation of the electric current, while at the end of the current the receiver reproduces the audible sound. The description which is given of the instrument is this:—"I am enabled to record the sounds produced by the human voice or otherwise by causing the movements of the diaphragm to be registered on paper or soft sheet metal, and then the paper may be used in an instrument to reproduce the sound upon a delicate diaphragm by giving to the same a vibration similar to that originally given by the voice." Then he proceeds to describe the figures:—"Fig. 4 is the indenting transmitter, the diaphragm having a knife-edge point; *i* is the paper which has previously been passed through a machine to raise a V-shaped rib, 6. The movement of the diaphragm of *h*, when the drum is in motion, causes the knife-edge point *l*[1] to indent the raised rib to varying depths, according to the amplitude of vibration of the diaphragm. Thus these indentations represent accurately all the tones and varying inflections of the human voice. The paper, after being indented, is passed through a second apparatus in Fig. 5, almost similar to *h*. A spring, 9, has a knife-edge, which rests upon the raised indented rib 6, the spring being connected to a delicate diaphragm, 10, by a string or straw. The indented rib reproduces in the spring 9 the movement of the indenting point, and either by direct action, or through the vibration of a string, conveys the same motion to the diaphragm of *n*, and reproduces previous sounds."

Now pausing here, it appears to me to be plain that Mr. Edison has described a substantive discovery of the very highest interest and ingenuity, by which at one spot this instrument receives and reproduces the human voice. Then he goes on to say, "If these sounds are to be transmitted over a telegraph line the diaphragm 10 is provided with a cork disc and fibrous tension regulator," and then, as I have already pointed out, the second diaphragm, instead of reproducing the voice at the time, acts in fact upon the tension regulator. Now what is the claim made by Mr. Edison in respect of that apparatus? It is this—"The method herein specified of recording the undulations of the diaphragm of yielding material, and the reproduction of sound by such material acting upon a diaphragm to communicate to the same vibrations similar to the original ones, substantially as set forth." It is impossible for me to read that claim and not to believe it to be a claim to the instrument whether used in combination with an electric current or not. Its capacity to produce sound without any relation to the electric current has been pointed out and dwelt upon. The mode of indenting was a novelty; the mode of reproducing that sound was a novelty; and the claim appears to me to cover the phonograph in both its applications, its application to produce human sound directly and immediately at the spot when the voice had been spoken to it, and its application also as a transmitter of the same voice at a distance. Has that remarkable discovery so made by Edison been in any manner described in the provisional specification? The statute, as we all know, requires that the provisional specification shall describe the nature of the invention, and before I proceed to consider the provisional specification in this case, I think it desirable to refer to some of the authorities which explain the principle upon which I ought to proceed in considering it. In the case of Bailey *v.* Robertson, which has been referred to so often during the course of the argument, Lord Blackburn very clearly explains the function of the provisional specification. At page 1874 his lordship says:—"The patent law dating from the time of James gave a monopoly solely to that invention of the first inventor; it, therefore, gave a monopoly solely to that invention which was his invention; he could not claim an invention greater than the title of the patent, but the titles were of extreme generality. It is in this particular instance 'for improvements in preserving animal substances.' Almost any kind of thing would come under that description; the mere title gave very little instruction. Then, in the time of Queen Anne, the Attoney-General of the day invented what was obviously a very great improvement. He made it a condition that the patentee should, within six months, particularly 'describe and ascertain' the invention and the manner in which it was to be performed, if not it should be void. If that was done at the end of six months, that specification fixed what was the invention for which the patent was granted. Then, during the six months, it would have been, and before specifications were invented it must have been, a question of evidence of what was the invention for which he went to the Crown, and for which the Crown granted a monopoly, and the traverse of that would be the proof. Then came the statute of 1852, which introduces a further amendment. It enacted that when persons went to apply for letters patent they should deposit a provisional specification. That provisional specification describes the invention in terms very different indeed from those in which the final specification described it. In this case, instead of saying, It shall particularly describe and ascertain the nature of the invention, and in what manner the same 'shall be performed,' all that the applicant leaves with the law officer of the Crown when he applies for a patent, he shall state the nature of the invention—no more than that; and then, when the law officer of the Crown, to whom it is referred, has looked at it and finds it does state the nature of the invention, but thinks the nature of the invention as stated is too large or too vague, he may require him to amend it; but if not, then he grants a certificate to use the patent publically without at all thereby making a present of the discovery to the public; and when it came to be a question whether or no what he was doing during that six months did avoid the patent, I take it the process must have been to say, look at the nature of the invention described in the provisional specification, and say whether this which you have been doing, and which you say was a part of the patent, is fairly within the nature of the invention you have described. In that case you are protected, but if it is a new and separate invention, and a different one, then you are not protected. I cannot but think that when that is once looked at it becomes pretty clear that, when the nature of the invention has been described in the provisional specification in the way which has been mentioned, if something were found out during the six months to make the invention work better, or with respect to the mode in which the operation may be performed, a thing which is very likely to happen when, in carrying out his invention, the inventor finds that some particular bit will not work so smoothly as he expected, and it is necessary to add a little supplement to it, still the nature of his invention remains the same, and it is no objection that in the complete specification, which comes afterwards, the invention or application is described more particularly and in more detail, or even if it be shown that there has been more discovery made, and so as to make the invention which he has described in the provisional specification really workable. If nothing more is done than that, I think it is good; but as soon as it comes to be more than that, and the patentee says, in the provisional specification I describe my invention A, and in the complete specification he says I hereby describe A, and also B, then as far as regards B, it is void, because the letters patent were granted for the invention that was described in the provisional specification, and do not cover the invention that is described in the other." Again in the case of Newall *v.* Elliott, the Court of Common Pleas made observations to a similar effect. "The office of the provisional specification is only to describe generally and fairly the nature of the invention, and not to enter into all the minute details as to the manner in which the invention is to be carried out." And similar language is used by the Master of the Rolls in one of the cases which have been referred to, where he says it might be roughly, but it must be fairly done.

Now I turn, with the light thrown by those cases as to the proper mode of construction, to the provisional specification in this case, and find that the title, which is to be read as part of the provisional specification, is, "Controlling by sound the transmission of electric currents, and the reproduction of corresponding sounds at a distance." And the inventor proceeds in this manner, he says—"The vibrations of the atmosphere, which result from the human voice, or from any musical instrument or otherwise, are made to act in increasing or lessening the electric force upon a line by opening or closing the circuit, or increasing or lessening the intimacy of contact between connecting surfaces placed in the circuit at the receiving station; the electric action in one or more electro-magnets causes a vibration in a tympan, or other instrument similar to a drum, and produces a sound, but this sound is greatly augmented by mechanical action. I have discovered that the friction of a point or surface that is in contact with a properly prepared and slowly moving surface is very much increased or lessened by the strength of the electric wave passing at such point of contact, and from this variation in the friction a greater or less vibration is given to the mechanism or means that produce or develop the sound at the receiving station, thereby rendering clear and distinct the sound received that otherwise would not be audible." I pause there to observe that it is plain that that description refers entirely to the transmission of sound or the controlling of sound by means of electric currents, or electricity in some form or other, and cannot in my judgment be taken to apply to an instrument which is capable of being worked in a very remarkable manner, without the application of electricity in any shape or form. Then the inventor proceeds in these words—"to carry out the peculiarities of my invention." It is obvious, therefore, that the substance of the invention has been disclosed in the preceding paragraph, "to carry out the peculiarities of my invention under the varying conditions of use I have devised several modifications of the transmitting, receiving, and intensifying devices employed in this sound telegraph," all evidently referring to sound to be transmitted to a distance, "portions of the apparatus are interchangeably available in transmitting or recording," and I observe, in passing, the evidence goes to show that at that time recording, as used in connection with telegraphy, meant some sort of telegraphic representation of the sound, because no other had been known till this invention was made—"others are adapted to local use," some are only available in "transmitting, and others are only for receiving, and some portions of my improvement can be availed of to make a record of the atmospheric sound waves or of the electric waves or pulsations corresponding thereto, or resulting therefrom." Now, no doubt, some of those words do explain, or might be held to refer to an instrument like the phonograph; but when I ask myself whether they in any manner describe the nature of the invention, I am bound to say that they do not. These, as I have already observed, are merely methods for carrying out the peculiarities of the invention; which invention, I repeat, is confined to the transmission of sounds by electrical agency to a distance. Supposing an inventor had, during the six months which preceded the complete specification, invented the phonograph, not as applied to the electric telegraph, but by operating itself, can it be said that the invention would have been protected by the description contained in this provisional specification of that instrument. I agree that the provisional specification need not describe the manner in which an invention is to be carried into effect. I agree that it need not describe the nature of the invention otherwise than roughly; but it ought to do so fairly and honestly, and if Mr. Edison was at the time at which these letters patent were granted in possession of that very remarkable mechanical invention by which speech could be reproduced, not necessarily at a distance, but in the same room as that in which it was uttered, I do not think the provisional specification was an honest statement of the nature of that discovery.

On that ground I come to the conclusion that Mr. Edison's patent cannot be upheld; and I must, therefore, grant an injunction in respect of the first part, and dismiss the action as regards the second.

Then arises the question of costs, and, upon the best consideration which I can give, I think I shall act in mercy to the parties if, instead of apportioning the costs, I grant the injunction without costs, and I do so accordingly. The form of the injunction will be the usual one. I think it will be found at page 352 of Sir Henry Seton's book: "The injunction be awarded to restrain the defendant, his agents, tenants, &c., during the continuance of the letters patent"—of course you refer to the particular ones—"or any extension thereof from manufacturing or selling, or disposing, or using any instrument of the same construction"—as to the two exhibits which you will introduce, "or only colourably differing therefrom, or any other instrument constructed according to the plaintiffs' patented invention, or only colourably differing therefrom, or being an enlargement of the plaintiffs' said patent, and from in any way infringing the plaintiffs' said patent."

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THE ELECTRICIAN.

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THE RECENT TELEPHONE DECISION.

In venturing to review some of the scientific details of the careful and elaborate judgment delivered on Friday last in the High Court of Chancery by Mr. Justice Fry in the late telephone suit two preliminary remarks will not be out of place. Firstly, remembering the adage, "*ne sutor*," these remarks will be confined strictly to scientific and technical matters, avoiding entirely questions of law and interpretation. Secondly, the care, patience, and extraordinary clearness with which the various points raised in evidence were treated from the Bench must have struck all persons in court. No trial could possibly have been more fair, and it is only to matters of scientific fact and their logical significance, some of which, amid the complicated issues raised, seem to have been overlooked, that the following criticisms, if such they can be called, are directed.

In the judgment, as printed from the shorthand notes, it is stated that the telephones which existed before 1876, "in certain cases were found, occasionally and uncertainly, to reproduce vocal sounds *with* musical ones, especially vowel sounds;" also that "an inventor, the German Reis, had gone a step further, and used a membrane to set a piece of metal in motion." Now, whatever Reis may or may not have accomplished, he was led by the study of the human ear to construct an instrument which he called a "Telephon," in which, for the first time, there was a combination of a *tympan* with a device for regulating, by means of a *loose-contact*, the flow of an electric current. This device, in which two pieces of conducting metal—preferably platinum —were brought into more or less intimate contact by the motions of the voice acting through the tympan, was, to borrow Edison's term, a "tension-regulator." The term—not a well-chosen one—signifies a device for producing variations in the strength of the current by varying the resistance under different degrees of contact. That it may, with strict propriety, be applied to Reis's platinum contact device is clear, because, as Sir W. Thomson has said, "the resistance between two perfect conductors in contact with one another may be continuously varied from a very large resistance to a resistance of a small fraction of an ohm." It is, therefore, true, as Mr. Justice Fry remarked (p. 11 of "Judgment"), that such a tension regulator as Mr. Edison invented had "been discovered in Reis's instrument." Now, this transmitter of Reis's invention transmitted not only song when it was sung to, but speech when it was spoken to, though in the latter case imperfectly, because, by reason of the delicacy of its construction, any very loud sound broke the continuity of the circuit—a result more disastrous to speech than to song, since to transmit the latter needs only that the number of the vibrations and not their amplitudes or forms be reproduced. The instrument became, in consequence, better known for song than for speech, though primarily intended for both. In his original memoirs Reis recounts how words were transmitted with curious fidelity as to the inflexion or modulation of the voice, though unfamiliar words were not readily recognised. Reis also mentions the importance of keeping the metal surfaces clean. That the instrument not only did speak, but was intended to speak (as a separate function from singing) is attested by a printed document now lying beside the writer, and in his possession since July, 1876. This document is a copy printed in 1865 of the instructions sent out with the instruments of Reis, and in it the person listening at the receiver is directed to signal to the operator at the transmitting end by means of a little Morse key (attached to the end of the receiver to serve as a "call") as follows:—"One tap, *sing;* two taps, *talk.*" It is, therefore, inadequate to the facts to speak of Reis's instrument as having "happened to communicate speech," when such communication was expressly intended and designed. Equally inadequate to the facts is it to say that such speech happened to be communicated "by intermittent currents;" for the transmission of speech with recognisable inflexions and modulations cannot be effected by intermitting the current with abrupt make-and-break. There is hardly a single telephone transmitter in practical use to-day that is not liable to break contact abruptly if subjected to too loud a sound, but when this occurs articulation is spoiled. To this accident Reis's telephone was even more liable on account of the lightness and delicacy of its contacts.

Another statement of the judgment that needs scientific revision is the following, with reference to telephones anterior to September, 1876:—"The fact that down to this time almost all the experiments which had been made or instruments which had been formed for the purpose of transmitting speech had used an instrument in the nature of a free reed or tongue. . ." What are the facts? To transmit speech Reis used a tympan, not a tongue. A tympan, not a tongue, was used in the old toy string-telephone. Tongues were only begun to be used when the musical tone-telegraphs were devised, in 1873 or 1874, in America for transmitting several messages at a time in the Morse code in different musical notes. Such telegraphs were devised both by Graham Bell and Elisha Gray. Each of these inventors, months before September, 1876, had passed from the problem of transmitting tones to that of transmitting speech, and each had already returned from tongues to tympans

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so soon as the problem of transmitting speech was to be attacked.

Again, it is stated that the "Bell receiver is capable of being used as a transmitter, a quality which does not belong to the Glasgow receiver." Without stopping to inquire what argument is based on this alleged difference in quality the writer will simply state that it is wholly illusory. He knows from his own experiments that the Glasgow receiver *will* act as a transmitter, and that it will, moreover, transmit better than the companion instrument which was shown at Glasgow as the "transmitter;" both of them will "receive," though the membrane telephone (the "transmitter") receives very badly.

The next point calling for remark is the following, which refers to Edison's transmitter. "It is plain that the mica structure is not, properly speaking, a tympan, because it is not strained. . . . . I do not forget that it has a certain action as a tympanum." Now, Edison's specification (page 2) runs:—"The tympans are of parchment, foil, mica, sheet-metal, or similar material." The printed evidence does not show that any witness on either side described the mica structure as vibrating in any other mode or manner than in that of a true tympan Every one of the diaphragms shown—and there are thirty-two of them visible—in the drawings of Edison's specification are true tympans. Further comment is surely needless, or would be if the suggestion that the mica structure is not a tympan were not so innocently at variance with the precise function served by that very definite organ in the combination claimed by Edison. In Edison's provisional specification the word "diaphragm" occurs but twice, and each time as an obvious synonym of "tympan." If in the complete specification it is not used in the same sense, then it includes not only more than is shown in the drawings but more than is included in the provisional specification.

The next and last remark will be by way of comment, not on Mr. Justice Fry's judgment, but on the theory of the telephone as apparently laid down by the claim to employ semi-conducting material in a "tension-regulator." It is well known as a universal law of electricity that any conductor, bad or good, conducts better when in perfect contact than when the contact is imperfect. Therefore, in this universal law there is, theoretically, a means of making a "tension-regulator" out of any material whatsoever that will conduct electricity, by applying Reis's principle of *loose-contact*. Moreover, it is readily proved that, *cæteris paribus*, the better the conductor the better its action in this respect. It is obvious that to throw the current into the most effective undulations in its strength, the changes of resistance introduced by the action of the loose-contact ought to be as large as possible in comparison with the total resistance of the circuit. Now, to produce these changes most effectively, which substance will answer best? It is clear that the resistance should be a maximum when the contact is least perfect, and a minimum when the contact is most perfect. The maximum resistance can be got either with good conductors or with bad conductors, since the resistance of *any* loose joint becomes infinite when all pressure at the point of contact is removed. The minimum resistance cannot, however, be obtained with a poor conductor, for with this, however great the pressure, the resistance will be greater than with a good conductor. It is certain, then, that with good conductors—*cæteris paribus* always understood—the effective changes of resistance will be greater. But, unfortunately, *cætera* are not always *paria*. The best conductors, silver and copper, for quite other reasons, deteriorate rapidly when used as tension-regulators; though they act excellently for a time. The metal surfaces oxidise, and are apt to stick by fusion. Long ago telegraphists knew this, and used platinum by preference as being less fusible and less rustable. Long ago, too, for the delicate contacts of relays it was suggested to use plumbago, which neither fuses nor rusts. Plumbago was *not* used in relays because it happens to be a semi-conductor. Now, taking conductors in order, the best first, and rejecting all that will rust or fuse, the first that remains is *coke*. Coke should, therefore, *à priori* form an excellent material for contact points to regulate the current; and, in fact, for telephonic purposes it is, in one form or other, almost exclusively used. Pure lampblack, which conducts thousands of times worse, and is relatively not even hemi-demi-semi-conductive, will not fuse or rust; but it required all Edison's skill and ingenuity to make of this unpromising material the lampblack button transmitter now practically discarded in favour of the Blake and other transmitters. There is, moreover, no connection whatever between conductivity and fusibility. Sodium, lead, tin, and bismuth are far worse conductors than silver, and far more fusible. Galena and a host of "semi-conducting" substances of kindred character are fusible, as is also selenium. Of the most absolute non-conductors known, some are quite infusible, others readily fusible. Edison has nowhere suggested infusibility as a principle to be applied in his transmitters, and of the substances he names as material for his semi-conductive tension-regulators several—for example, amorphous, phosphorus, and "soft metal"—are far more fusible than the best conducting of the metals is. The opinion that "all the high conductors are easily fusible, and all the semi-conductors are not so" is, unfortunately, against the scientific facts.

THE CRYSTAL PALACE EXHIBITION.

The Direct United States Cable Company.

In the gallery under the large clock the exhibit of the Direct United States Cable Company will be found. We have previously referred to the cables radiating to the East, but the system of this company is towards the West. The company was originally formed in 1873, but the cables were not completely laid until some two years after. The system was open to the public for traffic on the 15th September, 1875.

The cable extends from Ballinskelligs Bay, County Kerry, Ireland, to Ryebeach, Northamptonshire, United States, and has a total length of about 3,000 nautical miles. It is laid in two sections, the main section being about 2,450 miles from Ireland to Torbay, Nova Scotia, and the short section about 550 miles from Torbay to Rye Beach, New Hampshire, U.S.A.

The company started business with a tariff of 1s. per word, but this only lasted a fortnight, and the earnings under this rate were unsatisfactory. The cables were interrupted on several occasions, and in November, 1875, the tariff was raised to 3s. per word, but again reduced in March, 1877, during competition with the Anglo-American Company, to 1s. per word. During the whole of this period the financial results were anything but encouraging, and no dividend whatever was paid to the shareholders, nor was anything placed to reserve. This led to a reconstruction of the company; Mr. Pender, M.P., became chairman, with Mr. J. W. Fuller secretary and manager, and a joint-purse arrangement was made with the Anglo Company, the 3s. tariff being resumed. This tariff has since been varied, in consequence of further competition.

Joint-purse arrangements have also been entered into with the French Cable Company, and with the recently formed

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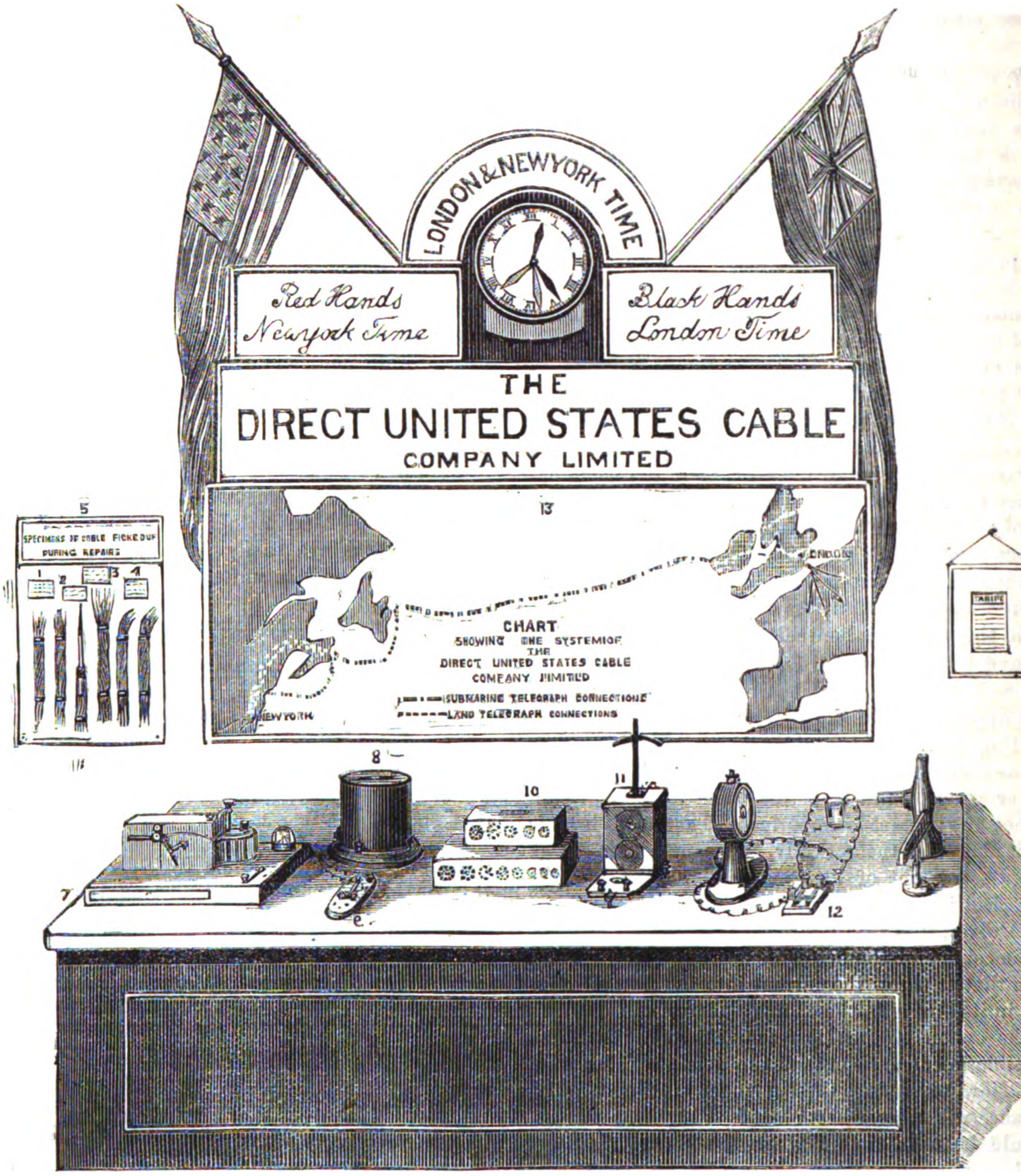
American Telegraph and Cable Company, and the tariff now established is 2s. per word, a tariff which we have reason to believe is considered moderate by the telegraphing public on both sides of the Atlantic.

The shareholders have every reason to be satisfied with the management of the Company, seeing that since its reconstruction in 1877 a dividend at the rate of 5 per cent. has been regularly paid, and a substantial reserve fund accumulated. In its recent joint-purse arrangement the Company has secured a strong alliance with the Western Union Telegraph Company of America, which owns and controls the whole of the telegraph service throughout the United States of America and Canada, and we hope that it marks the commencement of a long era of prosperity for the Direct Company and its allies.

The instruments exhibited at the Crystal Palace form a very interesting collection, and show the manner in which the company's entire system is worked between London, Liverpool, and New York. On the land lines on this side of the Atlantic the ordinary Morse printer is employed, while on the land lines on the American side the ordinary American sounder is in operation. Over the main section of the cable the mirror apparatus of Sir W. Thomson is used, and over the short cable there is through working between Torbay and New York, with Allan and Brown's relay and the aid of manual translating apparatus at Ryebeach.

Both cables are worked with Muirhead's duplex apparatus, which has been the means of increasing their carrying capacity to a very considerable extent, giving, in fact, additional transmitting power throughout, equal to a second cable. From the above it will be interesting to note that there is actually only one transmission between the shores of Ireland and New York city, through direct working between Torbay and New York having been established since the introduction of the Allan and Brown relay. The result of this has been a considerable acceleration in the time of transmission, which has been greatly appreciated by the public. As illustrations of the speed of the Direct Company's system, we may mention that ever since the company has been open for business the results of the "Oxford and Cambridge Boat Race," the "Derby," and other important sporting events in which the Americans take the liveliest interest, have reached New York within 30 or 40 seconds after being handed in at the company's London office.



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CORRESPONDENCE.

THE SELLON-VOLCKMAR ACCUMULATORS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Certain statements have lately appeared relating to the above-named accumulators or storage batteries, the patents of which belong to the "Electrical Power Storage Company." With regard to these statements, it is scarcely necessary to give any explanation to those who know me; but, as many who may be, nevertheless, interested in the subject do not, I shall feel obliged if you will publish the following particulars:—Having for long given attention to secondary batteries, and having succeeded in obtaining results which I considered of great value, I took out in England in *September* last certain patents, supplemented later by others. These patents would at the same time have been applied for throughout the world but for the necessity of awaiting the completion of my final specifications.

Towards the end of *December* Mr. Volckmar, whose name I then heard for the first time, was introduced to me as possessing a secondary battery of much merit, which upon examination proved to be in essential points the same as my invention. The patents had been taken out by him in October in many Continental countries, as also in England, and thus the position was, that although later than myself in his application for England, the Colonies, and America, he had anticipated me for the Continent generally. An arrangement was, therefore, made for the amalgamation of our respective interests.

At this juncture a patent was published, taken out by Mr. Swan, of Newcastle, in May, 1881, covering a portion of my first specification, and to prevent any possible difficulties arising in the future I purchased his rights for a considerable sum, and thus the combination of these patents was completed.

I need not here detail the features of the Sellon-Volckmar accumulator further than to say that in the judgment of some of the best scientific authorities of Europe it is an absolutely new and very valuable form of secondary battery, and in no way an infringement upon the Faure, which I assert it greatly exceeds in power and durability.

It was the intention of Mr. Volckmar and myself to deal personally with our patents, but a few intimate friends, who knew of the results obtained, expressed the wish to join with us in their development, and a small private company was formed *the internal arrangements of which are no concern of the public any more than those of a private firm*, inasmuch as no member of the public was ever asked to subscribe, or did subscribe, one single farthing.

The terms which were arranged for the cession of the patents to the Electrical Power Storage Company only concern those (all of high position and thorough business qualities) who approved of and entered into them.

The exact facts are, however, that *the cash paid covered only the expenditure already incurred*, the whole benefits of which were transferred to the company; and that we, the owners of the patents, who had the full right to ask what terms we thought fit, made our whole interest and profit in the business dependent upon its success; and that for a total amount of fully paid-up shares, which might, with the probable extension of capital, yield us each a proportion of the profits equal only to three-sixteenths, we ceded our patents *for the whole world*.

With regard to not guaranteeing the validity of the patents, no counsel of standing ever allows his clients to "guarantee" their patents, however sure they may be of their validity, and the usual clause, which I have always accepted myself in *purchasing* patents, was inserted in regular course. The case was, however, altered when applications were made for concessions or purchase of patent rights *after an attack, which we cordially invited*, had been threatened by the Faure Company, and it was determined to protect any subscribers to subsidiary companies against the contingency of an adverse issue by guaranteeing the return of all money received.

The Electric Carbon Company of Scotland has nothing to do with the Electrical Power Storage Company. Until I saw the prospectus in the newspapers I did not even know of its formation.

With reference to Mr. Volckmar, who I have found to be a gentleman of honour and integrity, the matter has come before the law courts, Mr. Volckmar having immediately upon the original publication of the libel commenced an action; and any discussion thereupon at present would be out of place.—Yours, &c.,

May 20th, 1882. John S. Sellon.

FAURE'S BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The following information may be of some interest to you:—"I reached New York yesterday (May 12th) in the French mail steamer 'Labrador,' that left Havre on Sunday, April 30th, having on board a shipment of seven tons of Faure accumulators, manufactured in Paris by the Force et Lumière Company. These accumulators were fully charged before leaving Paris, and were shipped on board the steamer at Havre in this state. Owing to want of space I was only able to make use of fifty cells during the voyage. With a portion of that number I succeeded in lighting up the smoking saloon of the steamer during the entire voyage with two Edison half lamps, the average time of lighting on each night being about five hours and a quarter. With the remaining cells I lighted part of the engine room and my own cabin, and made experiments with different types of incandescent lamps to test their suitability for steamship lighting. The cells I employed on board have not been touched, charged, or changed during the entire voyage, and I am perfectly certain that they still retain more than half of the charge with which they left Paris. They appear to have stood the voyage exceedingly well, although they were subjected several times to a drenching from salt water, and there seems to have been hardly any visible leakage. I am shortly going to commence the manufacture of these cells in New York, and prior to their completion I shall continue to make experiments with those I have brought with me from Europe." My name is doubtless familiar to you in connection with the Pullman limited express train on the Brighton railway, in which I made the first installation of lighting by accumulators on an English railway.—Yours, &c., W. Lachlan.

Coleman House, New York,
May 13th, 1882.

SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Will you please inform me if the following experiment is new:—I find that by adding about 5 per cent. of alcohol to the ordinary acid solution in a Planté secondary element that the action of forming is very rapid, and requires but an hour to develop a heavy oxide surface capable of taking a large charge.

My plan is generally to connect both lead plates to the carbon pole of several Fuller cells and a carbon electrode to the zinc pole, thereby developing both lead plates simultaneously. Afterwards I take out the carbon electrode and connect the lead plates to different poles.

I understand from Mr. Cuttriss, of the Duxbury Cable Station, that he, too, by the employment of a gas, has succeeded in hastening the forming action.—Yours, &c.,

Boston, May 8th, 1882. E. Berliner.

THE GRAMME MACHINE.

TO THE THE EDITOR OF THE ELECTRICIAN.

Sir: A circular has recently been sent round by the British Electric Light Company to the licensees for the sale and users of the dynamo machines made under the patents of Mr. C. F. Brush belonging to this corporation, claiming that the "Brush" machines are an infringement of the

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"Gramme" patent, granted in June, 1870, having, therefore, about two years to run.

With reference to this circular, I am instructed by my directors to state publicly that this company is prepared to guarantee the licensees and users of the "Brush" machines against any such claims, which, they are advised, are utterly untenable.—Yours, &c. (for the Anglo-American Brush Electric Light Corporation, Limited),

WILLIAM CORDNER, Secretary.

Belvedere-road, Lambeth,
May 24th, 1882.

SWAN'S SYSTEM OF ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your interesting article on Mr. Swan's exhibits at the Crystal Palace you say (page 15 of your issue for 20th of May)—"We may say that with any incandescent system there is absolutely no personal danger from contact with the wires." Now, at the commencement of your article (page 14, second column) you say that Mr. Swan makes use of "machines with a higher internal resistance (than Edison) and lamps of a lower resistance." This, taken in conjunction with the context, means, I suppose, that Mr. Swan uses currents of high tension, which are, I believe, dangerous to life.

I am puzzled to know, therefore, how there can be no danger from contact with the wires of this system. It seems to me that the act of touching the two terminal screws of the little lamp illustrated on page 14 would give one a smart shock, if nothing worse.

I can understand that there may not be so great danger when all lamps are arranged in multiple arc, even with high tension currents, but even then surely there cannot be said to be "absolutely no personal danger;" and if the lamps are arranged in series I take it there is great danger attaching to incautious handling of the wires.

If you will help me out of my difficulty a favour will have been conferred on—Yours, &c., A TYRO.

CURATIVE ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Agreeing with what Mr. Desmond FitzGerald has stated "That magnetism exerts no physiological action whatever," I wish to make a few remarks on Dr. Shettle's letter in last week's *Electrician* on curative magnetism.

We all agree that the earth is a magnet, but Dr. Shettle bases many of his arguments on the assumption that the attraction of gravity and magnetic attraction are the same force. If gravity be due to the magnetic attraction of the earth, gravity ought to increase as we approach the magnetic poles of the earth, just as the dip of the magnet increases. But, according to Dr. Shettle's arguments, a piece of wood, a block of stone, a sheet of glass, and a human being have the same properties as a permanent magnet; they are all subject, in different degrees, to the laws of gravity; gravity is magnetism; therefore they must be all, more or less, magnets.

Dr. Shettle mentions his own case as the result of the curative effects of magnetism. He says he experienced great relief by placing a band, made up of a number of permanent magnets, round his waist when he was seized with the attacks he mentions in his letter. The curative effects of placing a belt made up of a number of pieces of cold metal round the waist of anybody suffering from a nervous complaint I have no doubt would be very efficacious in many cases. I have also heard of the curative effects of a cold smoothing iron, of wet cloths, of a bottle filled with cold water, and, in fact, of ice placed on the pit of the stomach of persons suffering from attacks of indigestion.

To prove the effects of magnetism on the human body, Dr. Shettle says, let anyone stand between a sensitive galvanometer and a permanent magnet, and observe the effect produced on the galvanometer when the poles of the magnet are reversed. The effect that is observed in such a case is due to the direct influence of the permanent magnet on the suspended small permanent magnet in the centre of the galvanometer coil. The fact that the magnetic rays pass uninterruptedly through the human body proves what Mr. Desmond FitzGerald has stated "that magnetism exerts no physiological effect whatever."

Dr. Shettle might place a sensitive galvanometer and a permanent magnet each side of a stone wall, say three feet thick, and observe the effect on the galvanometer upon reversing the permanent magnet above mentioned. He would find it the same, whether the intervening space between the permanent magnet and the galvanometer were a stone wall or a human being.

For the mere interest of the matter, I carried out the following very simple experiments, which appear to bear out Mr. Desmond FitzGerald's conclusions with regard to the physiological effects of magnetism.

I used an astatic mirror galvanometer, so sensitive that a current equal to ·0013 of a volt would register a deflection of one division, I placed a powerful permanent magnet about three feet directly behind the galvanometer, with its poles in the same plane. Several persons passed rapidly between the galvanometer and the magnet without causing the slightest change in deflection.

I afterwards connected thick insulated wires to the holes of the galvanometer, and led the ends about fifty yards away. Whilst somebody held the distant end of the wires in each hand a powerful permanent magnet was passed up and down his body, round his waist and chest, without causing the slightest galvanometer disturbance.—Yours, &c.,

H. C. DONOVAN.

Morden Wharf, East Greenwich, S.E.

LITERATURE.

Elementary Lessons in Electricity and Magnetism. By SILVANUS P. THOMPSON. Second Edition. [London: Macmillan and Co.]

This little work supplies a want long felt both by teachers and students, and occupies a position which no other work hitherto published has been able to fill. The book is well designed, and interesting to the general reader, while it carries the student by insensible steps far beyond the boundary at which non-mathematical students have hitherto been obliged to stop, and gives them, at least, a very useful insight into those realms which few, except trained mathematicians, have hitherto been privileged to enter; and though it has been found necessary to darken the glass somewhat lest the too great glory of that land should dazzle the eyes of those accustomed only to Nature's darkness, yet the dark glass has been so applied that facts appear in their true relations, and the introduction to the study of electricity as an exact science is made sufficiently inviting to induce the student to desire a further acquaintance with it and with the mathematical methods necessary for its development.

The division of the book into two parts, in the first of which the more elementary phenomena are described and classified, while their more thorough investigation is relegated to the second part, is very convenient both for teachers and students. The first part, comprising the first three chapters, constitutes an elementary course of study sufficient for the purposes of some readers, and forming an excellent introduction to the more advanced course which occupies the remainder of the work. In the latter part many of Maxwell's results are presented in a more elementary form than any in which they have hitherto been published, while, at the same time, the accuracy of the statements and of the reasoning upon which they are based is in most cases maintained. It may be questioned whether the very brief accounts of some of the most important electrical and magnetic measurements will be of much value to the student, especially when no caution is given respecting the great errors to which some of the methods are liable, *e.g.*, those for determining the internal resistance of a battery; but this merely indicates that

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the whole of electrical science cannot be contained in a readable form in a pocket manual.

It would be of little value to the reader to enlarge further upon the good points of this useful little work. They will continue to be possessed by it, and will do much to advance the knowledge of the science. There are, however, a few points in respect of which we think slight alterations in future editions might be made with ease and advantage. Some of these we shall venture to point out, not detracting from the worth of the present work, but in the hope that its value may be increased in the time to come.

On page 9 it would be well to distinguish between *isolation* and *insulation*. A body is *insulated* when no electricity can enter or leave it. It is *isolated* when it is removed from the action of all other bodies. This distinction is useful, though not generally recognised.

The electrostatic unit of electricity is defined as "that quantity which, when placed at a distance of one centimetre from a similar and equal quantity, repels it with a force of one dyne." Now, this quantity will depend on the nature of the dielectric through which the action takes place, and to avoid difficulties in the future it is as well that the action of the dielectric should be at this early stage clearly recognised. The addition of the words *through air* to the definition will avoid the ambiguity and introduce the dielectric to the reader's notice. (The same remark applies on pp. 192 and 210.) A little later the dielectric receives full credit for the part it takes in inductive action, and on page 61 we are told that "the old theory of action-at-a-distance" is "logically unthinkable." This may be so, but it is dangerous ground on which to venture in an elementary treatise. Any hypothesis which leads to a deeper investigation into Nature's secrets is a step forward, and should be regarded as a scientific procedure. If, then, the introduction of a medium leads us to investigate the properties of the medium and the manner in which stress is communicated through it, we have, as Maxwell pointed out, made a step in advance, and the medium provides us with more to think about than the direct action theory; but whether the result ultimately arrived at is more "thinkable" than the other hypothesis we leave to professional *thinkers* to decide. There is, however, one point in connection with the action of the dielectric to which the attention of the student should be called. On page 61 it is stated that the glass of a Leyden jar is "squeezed between the attracting charges of electricity." Now, Faraday stated and Maxwell showed that there is a *tension* along the lines of force and a pressure (equal to it) at right angles to these lines. This is duly recorded later on in the book, but the student may have some difficulty in reconciling this with the statement that the glass is squeezed. Inasmuch as the material of the glass prevents the approach of the coatings to each other in obedience to their attraction, or, more properly speaking, to the tension of the dielectric between them, it must experience a mechanical pressure; but some light may be thrown on the matter by an illustration. Suppose two metal plates to be on opposite sides of a brick wall, but connected by stretched india rubber strings, which pass through holes in the wall. The wall, which prevents the approach of the plates, will be subject to pressure; but the elastic strings, which are the vehicle of the stress between the plates, and correspond to the dielectric, properly so called, are subject to tension. Remove the bricks and mortar, and the plates will approach one another, the strings contracting; remove the material particles of the glass, and the medium remaining will cause the armatures to approach, as in an air condenser, in virtue of its tension. In saying this, we do not imply that it is possible to remove the material particles of the glass without in some way modifying the dielectric, which is the vehicle of the electric stress.

On page 33 it is stated that the explanation of the fact that electricity resides only on the outside of charged conductors is to be found in its property of self-repulsion; "hence it retreats as far as it can from the centre, and remains upon the surface." This statement is, no doubt, put forward only as a partial truth; but the student is apt to infer that, so long as electricity repels itself, it will all go to the surface of conductors, whatever be the law according to which the force varies as the distance. Suppose a swarm of flies in a room all to repel one another, and that in virtue of the repulsion they recede to the walls, thus leaving the air perfectly free. It is surely conceivable that it would occur to one of the flies that, if he left the wall and took up his position in the middle of the room, he would then be farther from his neighbour than if he remained upon the wall, and other flies following his example might take up other positions in the room, so that the final state of affairs would be a surface distribution on the walls, together with a distribution through the air, according to some particular law. Whether this will take place or not depends upon the particular law of repulsion. If the repulsion varies as an inverse power of the distance numerically greater than the second, as, for example, the inverse cube, the flies would then be partly distributed through the air. If the student is at first led to believe that any law of repulsion will produce the same effect, he must fail to appreciate the argument which deduces the law of inverse squares from the experimental fact that there is no electricity within a closed hollow conductor.

The vexed question respecting the chemical theory of the voltaic cell and effects of contact of dissimilar metals is, unfortunately, still in such a position that an author is at liberty to enunciate almost any view he pleases respecting it, provided that he states clearly that the theory enunciated is simply his theory. We fail, however, to appreciate the reconciliation between the two theories supposed to be effected by the following statement (page 68):—"The real truth is that the electricity of contact and the chemical action are both due to molecular conditions of the substances which come into contact with one another, though we do not yet know the precise value of the molecular conditions which give rise to these two effects." This seems very like darkening counsel by words. Thomson's well-known experiment with the divided ring is quoted in support of contact electricity, but the result obtained by Mr. John Brown, of Belfast, who repeated this experiment in an atmosphere of sulphuretted hydrogen and found the potentials reversed, is not cited. The fact, as pointed out by Maxwell, is that the experiment only serves to determine the difference of potential of the air or other gas in the neighbourhood of the metals, and not the difference of potential of the metals themselves. The only method we have at present to determine the last-mentioned quantity is the measurement of the Peltier effect. In the "Contact Series of Metals," given on page 69, it is stated that the order is "in air," but no reason for this is assigned till we reach the foot note at the end of the chapter. On page 137 we are referred to paragraph 159 in order to learn "how the views of Volta and Faraday are to be harmonised." On referring back, as directed, we are disappointed at finding the harmony lie in this, viz., that the chemical and electrical behaviour of metals "probably both result from a yet undiscovered cause."

On page 126 we learn that when a plate of zinc and a plate of copper are dipped in water an electrometer will show that the metals and the water are all nearly at the same potential, but that if acid be added to the water it becomes slightly negative relative to the metals. We should be glad to know how the electrometer will prove this. An electrometer is capable of determining the difference of potential between two copper wires attached to the metals or between a copper wire attached to one metal and a second copper wire dipped into the water; but we know of no method of determining the difference of potential between a metal and an electrolyte. Even the Peltier method breaks down here, as Maxwell pointed out, because we do not know the exact nature of the chemical action which goes on in contact with the plates or the energy of the ions in the condition in which they are transferred through the liquid.

On page 81 we are told that "a fluid cannot propagate itself indefinitely without loss," and because a magnet can magnetise a piece of steel without losing any of its own magnetism it is therefore inferred that magnetism cannot be a fluid. We are far from wishing to maintain the contrary, but might not the same argument be applied to electricity on

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account of the phenomenon of electrical induction, and is it conclusive in this case?

The notion of electric potential is very properly introduced at an early stage of the lessons, and on page 40 it is explained to be "the degree to which a body is electrified." No mention, however, is made of the fact that a body may be unelectrified and yet at a very high potential on account of charges of positive electricity on other bodies in the neighbourhood, or may even have a negative charge and yet be at a high positive potential. In fact throughout the earlier lessons the student gets into the habit of always associating positive potential with a positive charge on the conductor at that potential, and negative potential with negative charge, and he finds it more difficult to "unlearn" this erroneous knowledge (?) than he would to get the true idea of potential if properly presented to him at first. On page 193 we have the formal definition of potential, but in the foot-note on that page it is stated that "'potential' must be understood as 'power to do work.'" Surely this is confounding potential with energy. Potential is an attribute of a point in space, and a point may be at a high potential though there is no electricity there; it cannot, however, be said to have power to do work, any more than a *point* a thousand feet above the sea possesses energy in virtue of its position and of gravitation. Electricity possesses energy when at high potential, and energy is the product of potential and charge.

The proof on page 195 that $V = \Sigma \frac{q}{r}$ does not require the integral calculus to make it "*complete*," but only a very slight change in the form in which it is presented. A complete elementary proof will be found in Maxwell's "Elementary Treatise on Electricity."

The theory of thunderstorms, given on page 255, is the following:—The clouds consist of extremely small drops of water which have become charged with electricity by evaporation going on upon the earth's surface. "Suppose eight of these minute particles to join into one. That one will have eight times the quantity of electricity distributed over the surface of a single sphere of twice the radius . . . . and its electrical potential will, therefore, be four times as great." From this it appears to be inferred that the potential of the cloud will also be increased. Now, it is quite true that if the eight drops were the only drops in the neighbourhood, and they were made to coalesce after being a long way apart, the potential of the single drop would be four times that of the original drops; but the potential of any drop of water in the cloud, *due to its own charge*, is very small compared with that due to the charges of the other drops in the neighbourhood, and consequently its potential will be increased only by a very small percentage on account of the coalescence, while the average potential of the cloud itself will not be sensibly affected by the coalescence of drops in every part of it. If, however, the larger drops fall, so that the *mean density* of the cloud near its lower surface is increased, its potential there will also be increased.

In the preface we are introduced to an old doctrine under a new name, *i.e.*, "The Conservation of Electricity." Whether this is a happy title or not we leave to others to decide. The notion that electricity in moving through conducting wires behaves like an incompressible fluid was entertained by Cavendish. Long before he had the opportunity of perusing Cavendish's paper Maxwell taught that electricity behaves like an incompressible fluid, and that all electric discharges consist of currents in closed circuits. Thus in the discharge of a Leyden jar the same quantity of electricity passes across every complete section of the dielectric as through the external circuit, the difference in the two cases lying in the fact that in the wire the electricity has free course, while in the dielectric it can move only through very small distances. According to this view, when a charge of positive electricity is given to an insulated conductor through an electrode an equal quantity is squeezed out through its surface into the dielectric, and an electric displacement, diminishing in extent as the area increases, takes place across every section of the dielectric, till some neighbouring conductors are reached, from which (if they surround the charged conductor) an equal quantity of positive electricity is expelled. In fact, if any imaginary closed surface is drawn it is impossible to increase the amount of electricity within that surface. Now, the conservation of matter and of energy only teach us that the increase of the matter or energy within such a surface is equal to the amount which passes through the surface. The conservation of electricity teaches us that the quantity of electricity within the surface *cannot be increased at all.* But in respect of this principle, and of the unity of the nature of electricity, the book is by no means true to its colours. Of this many examples might be cited. The explanation of the action of the cylinder machine on page 43 is in the language of the two-fluid theory. On page 11 we are told that "the quantity of electrification produced is, however, by no means equal to the amount of the actual mechanical friction." The meaning of this we scarcely hope to discover.

Many other minor points we have noticed, some of which are misprints. Twice in the statement of a law the inverse power of the distance is mentioned instead of the inverse square. On page 116 the intensity of the magnetic field is expressed in dynes, though it is not of the same dimensions as force. In the statement of Maxwell's rule on page 158 the positive direction is not specified. On page 181 it is not made clear whether electric distillation is, after all, distillation or not. From the statements on page 230 a student may infer that it takes several hours to send a signal through a long cable. In reading page 181 we confess to a curiosity to know more of the "prodigious effect" of the electric shock on the monks.

THE FAURE ELECTRIC ACCUMULATOR COMPANY (LIMITED).

The first ordinary general meeting of the Faure Electric Accumulator Company (Limited), was held at the Terminus Hotel, Cannon-street, on the 23rd inst., under the presidency of Sir A. J. Otway, Bart., M.P.

The SECRETARY (Mr. Herbert Canning) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, as this is the first occassion on which I have the pleasure of meeting you here, allow me in my own name and in that of the board to offer you my congratulations on finding so large an attendance—so many gentlemen interested in what I do not hesitate to characterise as the greatest invention of modern times—one I believe calculated to effect a revolution not by any means inferior to those created, as to light, heat, and motive power, by the use of gas and by the discovery of the power of steam. It will be my duty as concisely and as clearly as I can to state to you the position of this Company, and our view of its prospects. If I should fail in making our position clear it will be open to any gentleman present to ask any question of me by way of obtaining further information, and on this you may rely, that as far as it is in my power he will obtain that information in a straightforward manner. Now, gentlemen, before I proceed on those remarks which are necessary to elucidate the position of the Company, and to describe the work of the administration over which I preside, it is absolutely necessary that I should make a passing remark on an incident, and on a publication which has appeared with reference to this Company, but I shall do so in no unfriendly spirit whatever. I desire to consider both the incident and the publication really as resulting from a somewhat excited brain, and I desire to deal with a business matter in a business-like spirit. One rule I have made in life, from which I hope I shall never depart, namely, not to allow personal feeling to interfere in a business matter, and where I have charge of the interests of others I feel that it is exceedingly easy to sink any personal uneasiness in relation to such matters. Now, the incident to which I refer—and I dismiss it in one word—was the circumstance that a large shareholder, indeed the vendor of these patents, thought it right to summon a meeting of shareholders a few hours previously to this meeting, which had been previously announced to take place. I need scarcely say that the meeting took the exact view which I anticipated that it would take. It is not usual in England, and I hope not anywhere, to pass judgment on statements till you hear them, and, therefore, the meeting deferred any opinion till they had heard the statement I shall make to-day. With regard to the publication. I really cannot treat these publications seriously, but it is my duty to say that I do not accept any of the statements contained in them as giving a fair and proper representation of the state of things in this Company. If it is necessary I am prepared to refute them, but I believe it would only stir up ill-feeling, and so far as I imagine it would not be productive of any advantage to the shareholders, the property, or the board that I should do so. I must, however, say this—and on this statement I think you may found my opinion of the whole indictment of the board—I must say this with regard to the conclusions to which the writer of those allegations comes, the conclusion he came to after a short statement was that the best thing this Company could do was immediately to go into liquidation. Well, to ask a company that has a very large balance at its bankers, that owes no one 6d., that has never made a call on its shareholders, and that has what it conceives a most valuable property, that is now carrying on and has entered into contracts for profitable business, and has prospects, as soon as ever it can obtain those articles it was formed to sell (accumulators), of a very large and profitable business—I say that to

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ask a company under such circumstances to go into liquidation seems to me one of the strangest conclusions to which any man could possibly come. I now pass from all this to the consideration of what the Company is, what it has hitherto done, and what its prospects are. Gentlemen, this Company was not formed, let me say in a word, for gambling purposes. It was never the intention of the gentlemen who summoned me, any more than any one, to connect themselves with any company formed for that purpose. I can quite understand that gentlemen who have seen large fortunes made, and who will, perhaps, see large fortunes lost, in the gambling speculation going on at the present moment in electric light companies, are disappointed at nothing of the sort going on in this Company. Of course, really this Company was formed for a very important purpose—formed for the purpose of introducing to the public an invention, which, as I have said, I consider one of the most remarkable of modern times—an invention for the storage and distribution of electric energy to be worked under the patents obtained in this country by M. Faure. I have remarked on some process of the vendor of this patent, but let me say of that gentleman that he is a man of very remarkable ability and capacity, and one thing I entirely adopt is the very interesting memo he sent to me some time ago as to this patent, and that is the conclusion to which he comes—that the future belongs to electricity, that electricity must be worked by accumulators, that the accumulator Faure (that which we possess) is the only practical accumulator in existence, and that, although accumulators may and certainly will be invented, the Faure accumulator will hold its own, and that if it does not there is room for the Faure and other accumulators also. I adopt those conclusions entirely. I should have liked to give you a description of it, as there may be some who do not know what this accumulator is, but it would take far too much time. I wish, however, to state this—you find a most admirable description of the accumulator in a lecture given by Professor Ayrton at the London Institution in a little pamphlet which any one may possess. I propose from that pamphlet to select only one passage, as it deals effectively to my mind with an objection that was brought against the Faure accumulator as having disappointed some of the expectations formed of it. This is the quotation which I wish to read:—"When the Faure accumulator was first invented there were various suggestions of electricity being delivered at houses every morning like milk in cans, and the exaggeration of this idea no doubt did something to prejudice the cells in the eyes of the public. The reason why milk is delivered in cans and brought by carts is simply because the total quantity required is so extremely small. If milk were required to be consumed in large quantities like water is we should have it sent through pipes and not by cans. The main use of the accumulators will be as stationary reservoirs corresponding with cisterns for water or gasometers for gas. But in certain cases where the accumulators can be used to propel a cart, as in the case of tramcars—not the cart employed solely to carry the accumulators, then there is not the same objection to their being moved about, seeing that the total weight necessary is small compared with that necessary for a steam engine or a compressed air engine for tram lines to develop the same horse-power." In that sentence you have, to my mind, a complete answer to the only thing I have heard like disappointment expressed as to the Faure accumulator since it came to the public. I now pass to the work of the board and the constitution of the Company. When this Company was formed I must ask you to remember that we were dealing with an entirely novel invention. There was hardly anyone who knew anything at all about the accumulators, about their powers or their manufacture. We had, therefore, to look about us, and to see how best we could carry into effect the purpose for which we had come together, and for which we had invited the support of the public. We guided ourselves, in the first instance, by the advice of the gentleman who had great experience, to whom I alluded beforeas a man of great experience, as far as any one could have great experience of anything concerning accumulators—I mean M. Philippart—who was associated with M. Faure in the matter. He advised us as to the conditions under which we should proceed to supply ourselves with accumulators, and he recommended a very eminent firm in Liverpool, the firm of Fawcett, Preston, and Co., to be the makers of these accumulators, suggesting hereafter an idea which I think very excellent—that a construction company should be formed to develop the further construction and supply of these accumulators. Well, we entered into arrangements immediately with Messrs. Fawcett, Preston, and Co., and have succeeded in effecting a very good arrangement of a tentative character with that firm by which they are to supply us with a certain number of accumulators weekly on terms which will give what we consider a proper profit to the company. Our engineers, Professors Ayrton and Perry, went down to the manufactory of Messrs. Fawcett, Preston, and Co. last Saturday, and spent two days there, and reported that the manufacture of accumulators by Messrs. Fawcett, Preston and Co., which has only been quite recently started, is now progressing rapidly and satisfactorily, that over 300 large accumulators are now quite ready, and that the firm is now turning out 300 a week, and is arranging to deliver 1,000 a week if necessary. So much, therefore, for the work of Messrs. Fawcett, Preston, and Co. with regard to the delivery of accumulators. Well, gentlemen, we then said to ourselves that a necessary condition of a company such as ours was to be surrounded by men of acknowledged ability in the different branches they had to conduct. There was associated with the Company from its very beginning a legal firm which I do not hesitate to say stands second to none—Messrs. Freshfields. In all legal matters we have been guided by the advice of that firm. We secured the services of two gentlemen as scientific advisers whose names it is only necessary to mention—Profs. Ayrton and Perry, both of whom are here to-day, and we have secured their services on terms which I am perfectly sure the Company will consider satisfactory. We have a secretary who bears a name which is well known in scientific circles, and who is himself an efficient secretary; we have got a good staff, and we have obtained the services as manager of the Company of a gentleman who I do not hesitate to say is better qualified than any gentleman I know to manage matters connected with an accumulator company, in consequence of the large experience he has had in the company which first brought these accumulators to notice. He is now by my side, and I believe we shall find him a most efficient coadjutor and able manager. So much for the constitution of the Company. I have been connected now with powerful and successful enterprises in this city for many years, and I do not hesitate to say this—in none that I know of has there ever been so much attention given to the affairs of the company as has been given by this board, which has been styled an apathetic board. If I were to tell you the number of meetings this board has had you would be surprised. It will suffice, however, to say this—from the time we undertook the administration of your concerns there has not been a day, save Sundays, on which some members of the board have not met to consider the affairs of the Company, and how it could best be carried on. Well, gentlemen, we had at starting difficulties to meet. I believe any enterprise that is worth anything, that has a future, has, and must have difficulties to meet. It is, however, the duty of those concerned in conducting such an enterprise to overcome them, not to succumb to them. One of the principal difficulties was this—that when we were first launched into existence the public was skilfully prepared by mysterious paragraphs in newspapers, then by speeches delivered at banquets, and then by well arranged articles for the advent of another accumulator that was utterly to destroy and to replace this by its qualities. So that we did not feel that apprehension that some of our shareholders felt when all these mysterious paragraphs made their appearance. We adopted a very simple proceeding. We directed our solicitor to inquire the name of the writer, and also to take steps as far as was right and proper to proceed to action the moment that one of those accumulators that were so puffed and paraded were sold. We were advised that till certain proceedings took place we could not do more than take the first necesssary steps to defend our position. I must again do justice to M. Philippart, because no sooner was this assertion of ours challenged than he gave his name and address, and declared himself the author of certain allegations. No sooner was this new accumulator launched than we took steps that are necessary to protect the rights of this Company in the High Court of Chancery, and it is our intention to pursue these steps with all the energy that is necessary, unless we should be delivered from the necessity of war, by that which is always better than war, namely, a satisfactory peace. I presume that there is no one so fond of fighting that if he can get what he is going to fight for without fighting, he will not accept that. It is true that I have heard of some gentlemen who are never happy unless engaged in fighting, and, so fond are they of law suits, that when engaged in law suits with all their enemies, they will proceed to institute law proceedings with their friends and allies; but that is not our intention at all. We mean to defend the rights of our Company to the utmost of our powers, and to do so we have fortified ourselves by the advice of those who are most competent to give advice in such matters. First we have referred to a gentleman whose name will carry in this country the unquestionable weight of authority—we have referred to Sir Wm. Thomson, who has not the slightest doubt whatever that the accumulator of which we have heard so much is a direct infringement of our patent. We have fortified ourselves by legal advice, and have retained the services of most eminent gentlemen—I do not hesitate to say of gentlemen who are acknowleged to be most eminent in questions of this nature. We have retained the services of all these gentlemen, and as far as we have been able hitherto to gather legal advice, we have come to the conclusion that there is no question whatever that an infringement of our patent has been committed. If that is the case, all this advertising, all this puffing, is to our advantage. The more gentlemen prove that accumulators are necessary for all these electric light companies that are in the market, the more they prove our case. What could we desire more than that gentlemen should prove the necessity of accumulators, when we establish that we are entitled to everything that that accumulator does? We have but one thing, in my opinion, to be careful of, and that is to do nothing ourselves to damage our prospects. Of course, a house divided against itself cannot stand, and if people spread about ideas—ideas for which there is not the shadow of a shade of truth—that we are in any way doubtful of our patent rights, or the value of them, why no greater damage can be done to the prospects of this Company should such an absurd notion as that obtain credence. There is no foundation for it whatever. There is no one connected with this Company who has a right to have any doubt, because all authority we have applied to is against any doubt on that point. Therefore, our course is extremely simple. We have to defend our rights, and to establish them to the satisfaction of the proprietary, as I hope we shall by some means or another—if necessary, by proceedings in the High Court of Chancery. Now you will see, probably, what was your directors' programme, and I should like, in a few words, to tell you how far we have carried it out. Having associated ourselves with the gentlemen to whom I have alluded, and formed a company in the way I have related, we then asked ourselves, What are we to do? Well, the first thing was to get work—orders—and then get accumulators to allow us to carry out those orders. We thought we should do well if in starting we did this—if we got a public building, such as a very conspicuous and large hotel in which to use and show our accumulators; if we got the lighting of a well-known theatre, and showed the advantage of our accumulators; if we got the lighting of a very well-known and large private house in this country in order to show the value and use of our accumulators; if we succeeded in showing their value in the lighting of a railway train; and if we succeeded in showing their value in propelling a tram car. In almost all these things we have succeeded. In some of them we are actually at work, and in others we have contracts ready, which will be carried out as soon as ever we procure the accumulators. We have made an arrangement with the Grand Hotel, Charing-cross, an hotel sufficiently conspicuous to satisfy anyone, where our accumulators will very soon be seen at work. With regard to this, perhaps, you would like to know how far we have gone. The arrangements for the lighting of the large dining room at the Grand Hotel are now nearly completed, and this installation shows the enormous importance of Faure's accumulators, since it was made an essential condition that, as the engine room for the electric light is under a private dining room, the engine must not work during the evening. Hence, without the accumulators, the lighting of this hotel would have been impossible. We have also an agreement ready to sign at any moment with a most popular and conspicuous theatre—we could, indeed, sign them with several theatres if we were provided with the necessary accumulators. We have an agreement ready to sign and settle for the lighting of the private house of a nobleman very well known in this country, himself of scientific attainments, not very far from London. I do not know whether we shall be able to carry that out as soon as was expected. Here is, on my right hand, Mr. Edwin Freshfield, who presses us to light a church in which he is very much interested. We are quite

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prepared as soon as we can get the accumulators to light his church, and if we light his church successfully there is no reason why we should not light St. Paul's Cathedral. As you are aware, we have for six months been lighting without any assistance the Pullman car train which runs three or four times a day on the railway of which I am a director. I am a constant traveller on the railway, and I am enabled to give an opinion as to the practical working of the light, and I unhesitatingly say that it gives satisfaction. I hear nothing but satisfaction expressed by the numerous people who travel by that Pullman train. We have propelled a tram car of a most unwieldly character; nevertheless, we sent that tram car at the rate of seven miles an hour, and I have no doubt whatever that we shall very soon be able to send a tram car at a speed very far exceeding that. The difficulty we have is a very simple one—it is really that we cannot execute the orders which are ready to be given to us. We cannot get the accumulators fast enough, but we do hope, either by a great development of the works of Messrs. Fawcett, Preston, and Co., or by the creation of a company for the purpose of their manufacture to overcome that difficulty, and then I really do not know what limit to set to the work which may fall to this Company. As far as I can get instructions from others I hold the accumulators to be absolutely necessary to the successful carrying out of the electrical enterprise that is before us. This is our statutory meeting, at which no accounts are laid before you, and no accounts can be laid before you, but I have given the best of all accounts in the account I have been able to give you by word of mouth. What I ask of you is to have confidence in the administration of this affair by those able gentlemen by whom I am surrounded, and my own impression is that they are fully competent (I do not speak of myself) to carry your affairs to a successful issue, and I know that it is their wish and desire to do so. There may be some of you who differ from that opinion, and may think that others could manage matters more satisfactorily. If that is so, by all means place them here. We are not the men to stand in the way of the success of the Company if it can be better arrived at by others; but so long as we retain your confidence, and the duty and responsibility devolve on us of conducting this great invention, it will be our duty and pleasure to devote such time and ability as we possess to the administration of your affairs in such a manner as I hope will have the result of bringing about a large profit to those who have joined in this interesting enterprise.

M. PHILIPPART then addressed the meeting, speaking in French, and

The CHAIRMAN afterwards stated that that gentleman had in his remarks acknowledged the entire honour of the directors, and that a meeting, such as that which he (M. Philippart) had convened on the previous day, though unusual in England, was not at all unknown abroad. He had also expressed his satisfaction at hearing the steps that the directors were now taking. He, however, appeared to think that they should have gone more quickly and made more progress. On that he might remark that sometimes those who appeared to go slowly went best. Under the circumstances M. Philippart had expressed himself as being very much at one with the directors. Half the number of shares asked for had been *bona fide* applied for and paid up—20,083 among 357 shareholders. They also had £10,000 at their bankers. They would consider with other proposals the proposal of M. Philippart as regarded placing the remainder of the capital. Replying to Mr. Keyser, the chairman repeated the work which the Company had done and were doing, and again stated that they could not complete the contracts to which he had referred, as they had not yet obtained the necessary accumulators. The first delivery of accumulators would be made that week. The making of these accumulators was very delicate work. The other Company had produced no accumulators. This Company had now 300 large accumulators ready at Liverpool; they would turn out 300 a week, and they hoped to have 1,000 a week if necessary. He considered that it might be wise sometimes to further their business to show a light from which perhaps no great profit was derived direct.

Professor AYRTON, in reply to another shareholder, referred with satisfaction to the result of the visit of Professor Perry and himself to the works of Messrs. Fawcett, Preston, and Co., and pointed out the advisability of a little delay in order to ensure the quality of the accumulators. The experiment in connection with the Kemp Town train was of enormous importance. In the lighting of the Brighton Pullman-car train the accumulators were charged by a fixed engine at Victoria, and a sufficient store of electric power was put into them to enable them to keep the whole train lighted on the journey from Victoria to Brighton and back again, including the waiting at Brighton. In the case of the experiments with the Kemp Town train the electricity was produced directly by the motion of the train turning a dynamo-electricity machine in the guard's van, and the surplus of the electricity which was not required to produce the light was stored up in Faure's accumulators on the train. Without accumulators such a system was absolutely impossible. This experiment had been thoroughly approved of, and the engineer of the Brighton Company was now making arrangements to continue it on a much larger scale.

A SHAREHOLDER inquired the number of accumulators which would be necessary to enable the directors to declare a dividend.

The CHAIRMAN replied that that was not a question for a statutory meeting, and the directors had not gone into it.

A SHAREHOLDER stated that it was said that the excessive weight of the Faure accumulators was a great objection to them, and that the advantage of those who were pirating this Company's invention obviated that objection.

The CHAIRMAN replied that the weight of the accumulator for lighting the Pullman trains was 15 cwt. (not three tons, as the shareholder stated he had been informed). It was difficult for him to say whether the other company's accumulators were so light, as he had not seen one.

A vote of thanks to the chairman closed the proceedings.

THE ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on the 25th inst. at the Cannon-street Hotel to consider the agreement referred to at the meeting of the Direct United States Cable Company, which is fully reported in this issue.

The SECRETARY (Mr. T. H. Wells) having read the notice convening the meeting,

Viscount MONCK, who presided, reminded the propietors of the policy which he referred to on the last occasion as that which they were then pursuing experimentally, namely, that of reducing the tariff to a low rate, with the object of increasing the traffic so that all the cables would be filled. He was now able to state that the experience of that policy was not sufficiently encouraging to induce them to persevere in it. The Jay Gould cable having become an accomplished fact, they had felt it judicious to come to the agreement which the shareholders had been called together to consider. He then proceeded to remind them that the directors had no control whatever over new competitors springing up, but observed that as far as any agreement could do so, this arrangement would guard them in the future against fresh competition. The proportions in which the traffic was to be divided had been regulated by their reference of what the cables would take in competition, without reference to agreements at all.

The SOLICITOR, at the request of the chairman, having read the heads of the agreement.

The CHAIRMAN moved its approval.

The MARQUIS OF TWEEDDALE seconded to motion.

A discussion followed, to which the chairman replied, and the motion was then declared carried, with three dissentionts.

A vote of thanks to the chairman brought the proceedings to a close.

THE DIRECT UNITED STATES CABLE COMPANY (LIMITED).

An extraordinary general meeting of this Company was held at the Cannon-street Hotel, Cannon-street, on the 25th inst., "to consider, and, if approved, to confirm and adopt an agreement made between this Company, the Anglo-American Telegraph Company Limited, La Compagnie Française du Télégraphe de Paris à New York, and the American Telegraph and Cable Company, with respect to the division and appropriation of the traffic receipts. By this agreement, taken in connection with the existing agreements between this Company, the Anglo-American Telegraph Company and La Compagnie Française du Télégraphe de Paris à New York, the joint receipts of the four cable companies will become divisible in the following proportions:—From the date at which the American Telegraph and Cable Company shall have one cable in complete working order and condition, and regularly opened for traffic:—18·375 per cent. to the Direct Company, 55·125 per cent. to the Anglo Company, 14·000 per cent. to the French Company, and 12·500 per cent. to the American Company, and from the date at which the American Telegraph and Cable Company shall have two cables in good working order and condition, and regularly opened for traffic, the division of traffic receipts will be in the following proportions: —16·275 per cent. to the Direct Company, 48·825 per cent. to the Anglo Company, 12·400 per cent. to the French Company, and 22·500 per cent. to the American Company. The above division of traffic receipts is subject to certain modifications in the event of interruption of the respective cables."

The SECRETARY AND TRAFFIC MANAGER (Mr. J. W. Fuller) having read the notice convening the meeting as above,

The CHAIRMAN said: Gentlemen—Before putting the resolution which we have invited you to come to approve to-day I shall make a few remarks, so as to give you a fair idea of the present position of things and our reasons for entering into this agreement. We have called you together to-day for a special purpose. This is the third time that I have had the honour of addressing you at an extraordinary meeting. The first was to ask your approval of a joint-purse arrangement with the Anglo-American Company. That has been carried on for some time, and, I believe, with very fair success. The second, to ask your approval of an arrangement of a similar nature with the French Company; and now, for the third time, to ask your approval to probably the most important of all, I refer to the joint-purse agreement which we have just completed with the American Telegraph and and Cable Company, and we have also made a working arrangement with the Western Union Land Telegraph Company, a company to which I alluded at our last half-yearly meeting. At that meeting, you will remember, I gave you a considerable amount of information, not only on the subject of the 1s. tariff, but also of the formidable opposition which we were about to meet. I also indicated that a great deal of time and money might be required to maintain our contracts with the various land-line systems in America with which we had traffic arrangements, viz., the Atlantic and Pacific and the Franklin Companies in the United States and the Dominion Telegraph Company in Canada; and these companies, having been brought under the control of the Western Union Company, made the difficulties still more complicated, and gave us a still more powerful combination to contend with. I foresaw in this a very formidable competition, lower dividends, and vast law expenses, and I may tell you, gentlemen, that expensive as law is in this country, it is still much more so on the other side of the Atlantic. Therefore, it became a serious question whether it would not be desirable to come to some arrangement if one of an honourable nature could be come to, beneficial alike to this Company and to all parties. (These are the reasons which induced us to go into these negotiations, because we know perfectly well that competition means lower dividends, and in many instances no dividends at all. The dividends we have been paying have not been by any means excessive, and it is our desire to maintain for this Company, as we have from the time we became directors of it, a uniform dividend. This we have done at 5 per cent., and this I hope, through these arrangements, we shall be able to continue to pay to our shareholders.) Our first attempts in that direction failed, but there was an evident desire on the part of the American Cable Company and of Mr. Jay Gould, who created it, that some understanding should be arrived at. I have always held that arrangements between telegraph companies are desirable where they could be mutually beneficial. Well, gentlemen, negotiations were reopened, and the result is the agreement now submitted to you, which I hope will prove satisfactory. I am therefore before you to-day to ask you to sanction it, and before doing so I think it right that I should give you a slight sketch of the companies with whom the working arrangements are

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entered into. The Western Union Company has the control of the telegraphic system of the whole of the vast territory of North America, including Canada, representing a capital of upwards of sixteen millions sterling. To form an idea of the enormous extent of their system I may mention that the length of wire owned and controlled by them is 327,171 miles. You will better realise this when I state that the total length of wire of the British Post Office system is 116,680 miles, and I may also mention that we have the assurance that if direct land wires are required between the sea board and the important cities of America, so as to give every possible facility to submarine telegraphy, they will be constructed by the Western Union Company, and I may tell you that such is our confidence in the power of that Company that we have made it part of the arrangement that they shall take over during our pleasure our offices in New York and work our land lines between there and our cable termini at their own cost, and I may say, gentlemen, that this bargain will, I believe, benefit our exchequer to the extent of some thousands a year. Of course, if any competition should arise which would necessitate our taking posession of our offices again we are at perfect liberty to do so, and we have reserved to ourselves the right to do so; but, having such a powerful connection on the other side to protect our interests there, we do not anticipate any competition that will require such a change. You will see, gentlemen, from these arrangements that we have secured a very powerful ally in America—so powerful, that they will be bold indeed who will attempt to lay down cables to America in the face of a company possessing the whole control of all the land telegraph systems both of America and Canada. But no doubt we shall hear of such competition. Indeed, only a day or two ago I heard of another company which was to come out with a 9d. tariff, which, after allowing for outpayments, would only leave about 6d. as the cable company's proportion. Now, gentlemen, we can speak with some confidence on this question of rates. We have given the 1s. rate nearly a year's trial, and we find that had we gone on for another year we should not have been able to declare the dividend, moderate as it is, which we have done since this Company was reconstituted. We have also the experience of the French Company, who are under the control to a great extent of the Telegraph Department of France. Before that Company changed the tariff from 1s. to the present rate of 2s. they were obliged to satisfy the Minister of Telegraphs that the 1s. rate was unremunerative; and I believe, though I have not been officially informed, that the advice of the Government accountant who was sent to inspect their accounts was that they ought to charge 3s. instead of 2s. per word if the shareholders were to receive such a return as they were entitled to expect. Mr. Jay Gould also discovered that a 1s. tariff would not give a fair remuneration on such a property as this. As evidence of this you will remember that while we were working at 1s. he opened his cable at a 1s. 6d. rate; and, finally, he intimated to us that, even if no arrangement were made, the 2s. tariff was the one which ought to be adopted. These arrangements have led to our resuming the 2s. tariff. I may mention, as a justification of this step, that during the whole of the time the 2s. tariff was in force we never had any complaint from those who used the cable, and were, therefore, principally concerned; and I find now that the tariff has been advanced, that a similar feeling of satisfaction has been expressed, and for this simple reason—that a 2s. tariff as against a 1s. in large commercial operations is but a very small percentage upon the operation itself, and, consequently, rarely influences in any way the number of telegrams forwarded. If we had found by experience that the 1s. tariff would have given us such an amount of traffic as would have secured to us the very moderate dividend that we have hitherto been able to pay you, we should have continued at the low rate, but strange as it may seem, our experience with the 1s. tariff has been that even lately, instead of the traffic showing a growing development, it has actually diminished. That is a very remarkable fact, and it is well that you should know that the 1s. tariff has not induced the amount of traffic we naturally expected. I may say further—for I believe in very considerable progress in the submarine telegraph system—that, had we continued at the 1s. tariff till we got as much out of that tariff as we are now getting out of the 2s. rate, it would have cost the combined cables something like £2,000,000 sterling. That is a very important fact, and it is one that the public should understand as well as the shareholders, and I mention it as showing that we are carefully watching your interests, and trying, as far as we possibly can, to maintain not only an efficient system of telegraphy, but, at the same time, pay a moderate dividend to our shareholders. There would be nothing so dangerous as to render telegraphs unremunerative. I do not exaggerate when I say that three-fourths, and probably nine-tenths of the trade of the world is carried on by the aid of submarine and land telegraphy. The commercial world could not live without it; the political world would be in a state of tension, and commercial enterprise would suffer greatly were these cables interrupted, or were the companies placed in the position of having worn out cables, and no reserve wherewith to replace them. Therefore, it is in the interest of the public, of governments, and of the commercial community of the different countries of the world—aye, and of social life, that these submarine systems should be maintained, and maintained so as to give a moderate dividend to the shareholders. I believe now that this combination just completed makes it the most powerful of its kind in the world. I believe that those on the other side of the Atlantic, with all their natural enterprise, are with ourselves earnestly interested in giving their first consideration to having a thorough, complete, and efficient service. I may, I think, without any breach of confidence, read a telegram which I have received among others. It runs as follows:—"Gould, New York, to Pender, London. I have received your message advising me of the execution of the cable contracts. I am greatly pleased that they are finally settled, and hope and trust they will prove profitable to all interests, and this result can beyond doubt be achieved if we only pull together strongly in the line you indicate of improving and perfecting our international exchange of telegraph business." Now, while I have said that this is perhaps the most powerful combination ever entered into, some might call it by an ugly name, and say that it is a great monopoly; but I hold that there is nothing of the monopoly character in it. You cannot call a system of combination which gives an efficient service to the public, and only yields a 5 per cent. return—you cannot call that monopoly, and therefore I say that the public, whose interests should be protected as well as those of the shareholders, are largely benefited at the present moment by the combination which has just been completed. I have, therefore, shown you gentlemen that in all these negotiations the interests of the telegraphing public have been carefully considered. I also hope that this new arrangement will enable us to maintain at least the 5 per cent. dividend, and such a reserve fund as will make our property permanent by providing us with the means of replacing our cable when it should cease to live. I have said in a previous part of my remarks that I believe three-fourths, if not nine-tenths, of the whole of the business of the world is carried on by the aid of submarine telegraphy. As proof of that I have been watching the negotiations in respect of the present agreement and arrangement, all of which have been carried on by cable; and most important negotiations you will admit they are, representing or involving, as they do, a capital of over ten millions sterling. The speed, the accuracy, and the time saved has astonished me, although I have been so long connected with submarine telegraphy; and I was amazed that human thought should be so rapidly transmitted and retransmitted, so that a lawyer sitting here one day had in the morning an answer to the points dealt with on the previous day. All this leads one to believe that telegraphy has now got such a hold of the various interests of the world that it is simply impossible that they can do without it, and that its progress is as certain as that the sun appears in the heavens. As an interesting fact in connection with our cable, and showing the celerity with which events can be communicated across the Atlantic, I may mention that the name of the winner of the Derby race yesterday was transmitted from our London office to New York in 35 seconds. I have given you a little, I hope, pleasant information on the subject of telegraphy. I have shown you that we are attending to your interests in making this arrangement. I cannot say that no other company will come forward to compete; but I say that any other company now attempting to compete with those who have the control of the whole system of America will regret it. As a gentleman has said to me, I should like to sell the stock in that company at 50 per cent. discount the day it comes out. It is impossible that it should be a success without an enormous sacrifice of time and money; and as to waiting till telegraphy increases so as to give a return on the amount of the fresh capital invested, the only view I can take of it is that it would be a folly that does not exist in the mind of any man at the present moment. With these remarks I shall ask the solicitor to read the heads of the agreement we have entered into with the American Telegraph and Cable Company.

The Solicitor (Mr. John Mackrell) having accordingly read the principal features of the agreement,

The Chairman, continuing, said: Now, gentlemen, you have heard the heads of the agreement read, and I shall, therefore, read the resolution. If any gentleman has any remark to make upon the heads of the agreement or the observations which I have just made, I shall be glad to hear him and to give him the best answer I can. The resolution is:—"Resolved. That the agreement now submitted to this meeting, dated the 12th May, 1882, and made between the Anglo-American Telegraph Company Limited, the Direct United States Cable Company Limited, and La Compagnie Française du Télégraphe de Paris à New York of the first part, and the American Telegraph and Cable Company of the second part, be, and the same is hereby, ratified and confirmed, and that the directors be, and they are hereby, authorised to carry the same into effect."

Mr. W. Ford: I beg to second that.

The Chairman: If any one desires to make any remarks I shall be very glad to listen to them now.

Mr. Jackson: Without occupying much time I should like to say something with respect to this agreement, or rather with reference to the prospective policy of the united board under the circumstances of this arrangement, which you have designated, and which we must presume generally is, a very powerful combination—the most powerful yet attempted by the Atlantic Telegraph Boards. Viscount Monck said to-day that the policy of the Anglo-American Board was to secure to their shareholders a moderate or fair dividend with the lowest possible tariff, and I think that that is the principle on which the united companies should act as anticipating, or rather as preventing that competition which you decry, and which we, no doubt, would have very much suffered from in the establishment of these two new cables had not such an arrangement as this been come to. If you could publicly state—and I wish it had been so stated at the Anglo-American meeting—that after a fair and moderate dividend on their stock, the policy of the companies would be to reduce the rates, and not to take advantage of the possible consequences of this organization, it would have a beneficial effect. Though you may say that the object of the boards of these companies is not monopoly, yet still it could be worked as a monopoly under favourable circumstances. It is to be presumed that a fair dividend on the general capital of the companies could be obtained at a 2s. tariff in a very moderate period even. There is a very considerable amount of capital to come in to share those receipts. The enumeration by you of such a policy, which I believe is the feeling of the board of this Company, that a moderate dividend and sufficient reserve for renewals would satisfy them, and that they would be prepared to share with their customers any further increment of dividends in the reduction of tariffs, would, I am quite sure, be the only policy which, under the circumstances, could stop that extraordinary speculation or enterprise which is ready to float Atlantic telegraph companies with the certainty of 50 per cent. discount of their capital to which you have referred. You know better than me, but it is perfectly certain that, notwithstanding that discount, national susceptibilities have to be satisfied. The French nation would not be content to have its messages carried over a friendly line of another country; Germany felt the same; and the principal source of our revenue—America—held the same view. Well, these great countries, which represent the bulk of the trade carried over these cables, are now in possession of their independent lines, and I think that the ground for competition has very much been cut away; but still, once take advantage of a possible position, and seek to pay the same dividend as a water or gas company, competition will again be encouraged. The Anglo-American Company paid 9 per cent. in 1870. I know that, for I had the pleasure of receiving it, and in 1872 that company paid 10 per cent. and a bonus of 2 per cent., but then it had a monopoly. There was no competing line. If the directors of these united companies should be tempted to take advantage of their position I hope you will say that it is not only the intention but the resolution of this Company to be satisfied with a moderate dividend and sufficient reserve for renewals, and that any benefit beyond that from this arrangement will be divided among their customers. I think that that

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decision would be most important in preventing the competition which you have so often decried.

The CHAIRMAN: Gentlemen: When we gave the 1s. rate, we did it with the honest desire to benefit the large telegraphing public, and to satisfy ourselves as to whether that would be a remunerative tariff for the shareholders. As I told you in the few remarks I addressed to you, we found that that 1s. rate not only did not give us a return, but that looking at the percentage, looking at the progress made, it would have taken five years before the 1s. rate would have given us the same return as the 2s. rate. You would, therefore, have required to spend over £2,000,000 sterling to get the return from the 1s. which we are now getting from the 2s. tariff. Of course, even at the end of the five years, it is difficult to say whether we should have got it or not. We are as anxious to have low rates and large traffics as any one. We have tried very high rates. We had a considerable period of 4s., and a considerable period of 3s. We then went down to 2s., 1s., and at one-time 6d.; but watching carefully the different rates, we think that that which is not considered at all too high by the telegraphing public is the 2s. tariff, and we consider that that rate is one which will be fairly remunerative. We, therefore, decided at the present moment to make that the tariff. If there should be such a change that we conceive it would be better to lower the tariff, we have not made a rule which cannot be broken to-morrow. The real question for us to consider is the rate that will be most satisfactory to the public, and at the same time give a fair return to the shareholders. As to what we call the *amour propre* of France and America, France was determined to have her cable, and she has got it. With regard to America, what has astonished me, as I have said at previous meetings, was that the Americans were so long without a cable of their own. They have an enormous traffic between this country and America, and I have often thought why they did not have a cable, with their capital and enterprise. However, they left us to do the work. We have been the pioneers and leaders in every way. They have now chosen to come in, and I do not see any harm in letting them have a fair proportion. The proportion they are now to receive is not the full proportion for the two cables which are to be made. In another year we may, after all, find that we are strengthened by these two new cables instead of being what I call lessened in our dividend. I am quite hopeful that with the tariff we have now fixed we shall get such a return as will enable us to continue our 5 per cent. dividend, and maintain the reserves which we have provided hitherto. I have spoken of *amour propre*, and it was said that Germany had some idea in the some direction. There is now direct telegraphic communication between Germany and New York, *viâ* the Atlantic system of telegraphy, by the submarine telegraph just completed between Emden in Germany and Valentia in Ireland. Germany, therefore, without coming through London or France, has now her own cable between Germany and New York. Therefore, we have met the *amour propre* of these countries. Each country has communication with New York, and I am hopeful, looking at the combination now formed, that we shall have a little peace in the Atlantic for some time. At all events, what we have done to-day is in the belief that it was better to do that than in competition throw away a large sum of money, and probably disgust our shareholders as well. With these remarks I will now put the resolution. Those in favour of it will please hold up their hands. To the contrary. Carried unanimously. I am obliged to you for your attendance to-day, and I believe I may congratulate you on what I believe is a very fair arrangement in the interests of all concerned.

Mr. JACKSON: Before we separate I think that a vote of thanks is certainly due to our chairman on this occasion. I think, too, that our prospects are brighter than they have been for some time. I move that our best thanks be given to the chairman and his colleagues.

A SHAREHOLDER seconded the motion, and it was carried unanimously.

The CHAIRMAN: On behalf of my colleagues and myself I thank you. You may rest assured that there is no part of your interests that we are not watching carefully, and this has been a very anxious time. These negotiations have been going on for six months. Every point has been fought carefully, but I hope and believe in a spirit of bargain so fair that both parties are satisfied with it.

The proceedings then terminated.

THE LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY (LIMITED).

The annual general meeting of this Company was held last week at the offices, Old Broad-street. Mr. Pender, M.P., presided, and, in moving the adoption of the report and the payment of a dividend of 3s. a share, stated that the revenue of the past year had been £18,300, showing a decrease of £2,800, as compared with the previous year. This decline was attributable to the undue competition of the land lines of the Brazilian Government with the cables of the Western and Brazilian Telegraph Company, upon whose traffic this Company depended for their dividends, and also to the frequent interruptions of the cables of that Company. It was satisfactory, however, to know that the Western and Brazilian Company were putting all their cables into efficient order, and they had recently re-established communications with Para, a most important station. The debt of the Uruguayan Government had increased from £7,443 to £8,311, but any portion of the land-line receipts not already collected had not been considered as profit. He thought they would in time be able to realize that debt. An anonymous letter had appeared in *The Times* commenting on the honorarium of the directors. As he stated at their last meeting, the directors had voluntarily reduced their fees. They had, he asserted, positively rescued the concern from ruin, and for the trouble in connection with doing so they had received £300. When the undertaking was re-established and it was made an English company they put aside to a reserve fund a portion of the honorarium which was granted to the directors on the formation of the Company. The Western and Brazilian Company were now negotiating with the Brazilian Government as to taking over their system, which included this Company's; and, should a satisfactory conclusion of those negotiations be arrived at, it might be necessary to call another meeting.—Mr. Hollocombe seconded the motion.—Mr. Robinson Kendal contended that dissatisfaction was felt at the amount of the directors' fees, which, he said, represented one-ninth of the entire net revenue of the Company. He urged the amalgamation of the Company with the Western and Brazilian Company, and concluded by moving an amendment to the effect that the dividend be paid, but that, instead of adopting the report, the meeting be adjourned to enable the directors to alter the Articles of Association so as to reduce the annual remuneration of the directors from £1,200 to £600.—Mr. Roberts seconded the amendment.—The chairman, in replying, stated that the directors were quite agreed as to the advisability of an amalgamation with the Western and Brazilian Company, for which object negotiations had been going on, but it was a question of terms, and they were determined to maintain the preferential position which this Company enjoyed compared with the other Company. Their remuneration was not £1,200 but £1,000. In reply to questions he said the capital cost of the land-lines had been £90,000, and, as they were efficiently maintained, it was not so necessary to make provision against their depreciation as in the case of submarine lines. The Company, too, was only just emerging from its troublous into a prosperous condition. The debentures would fall due in 1884, and he hoped they would be able to renew them on more favourable terms. He then put the amendment, which he declared lost on a show of hands, and afterwards put the resolution, which he declared carried.—A poll was demanded by Mr. Kendal.—The retiring director and auditors were next reappointed, and the poll was afterwards taken, with the following result:—In favour of the motion and against the amendment, 12,860 votes, to 1,718 of which a technical objection had been urged; and against the motion, and in favour of the amendment, 7,735.—The chairman, therefore, declared the amendment lost and the resolution carried.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES MAY 24.		BUSINESS DONE WEEK ENDING MAY 24. Highest.	Lowest
Anglo-American	54⅞,	55⅛	55⅜	53⅞
Do. Preferred	86¾,	87¼	87¾	85½
Do. Deferred	24¾,	25¼	24¾	24
Brazil Submarine	11¼,	11½	11⅝	11⅜
Cuba	8½,	9	8⅝	—
Do. Preference	15½,	16½	16¼	—
Direct Spanish	5¾,	6¼	—	—
Do. Preference	14½,	15½	—	—
Direct United States Cable	12⅛,	12⅝	12⅞	11⅞
Eastern Telegraph	10⅛,	10⅜	10 5-16	10 3-16
Do. 6 per Cent. Preference	12¾,	13¼	12 15-16	12⅞
Do. 5 per Cent. Debentures, 1899	102,	107	—	—
Eastern Extension	11⅛,	11⅜	11⅝	11⅝
German Union	9⅜,	10	—	9⅞
Globe Telegraph and Trust Company.	6⅜,	6⅝	6⅝	6 7-16
Do. Preference	12⅛,	12⅜	12½	12⅛
Great Northern	12¾,	13¼	13⅛	—
Indo-European	28,	29	—	—
Mediterranean Extension	2,	2½	—	—
Do. Preference	8½,	9	—	—
Reuter's	12½,	13½	—	—
Submarine	265,	275	263	—
West India and Panama	1¾,	2	1⅞	1 13-16
Do. 1st Preference	8½,	8¾	8¾	8⅝
Western Brazilian	7	7½	7 7-16	7¼
West. Union 7 per Cent. 1st Mortgage	121,	126	—	—
Do. 6 per Cent. Sterling Bonds	102,	105	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1 15-16,	2 1-16	2	1 15-16
Oriental	½,	¾	13-16	¾
United Telephone	15½,	15¾	17¼	14½

ELECTRIC LIGHT.

Electric Light and Power	1¼,	1½	1¾	1
Anglo-American Brush (£4 paid)	22½,	22¾	25¼	21

TRAFFIC RECEIPTS FOR APRIL, 1882.

COMPANIES.	April, 1882.	April, 1881.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	3,800	3,193	607	—
Direct Spanish Telegraph Company	1,824	1,337	487	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	29,269	26,746	2,523	—
Eastern Telegraph Company	42,667	45,289	—	2,622
Great Northern Telegraph Company	17,640	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

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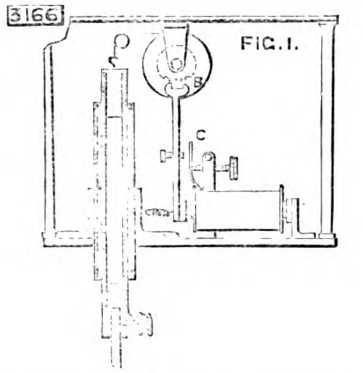
RECENT INVENTIONS.

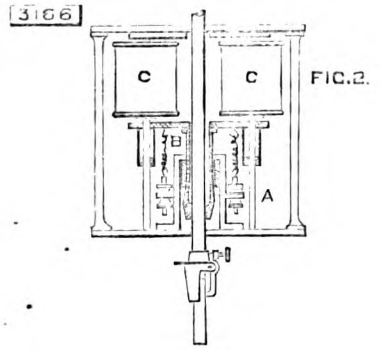
ABSTRACTS OF SPECIFICATIONS.

3166. ELECTRIC LAMPS, *W. Morgan-Brown, London.—20th July*, 1881.—(*A communication from G. P. Harding, Paris.*) 6*d*.

In one form of lamp, to regulate the arc the inventor uses an escapement, B, actuated by a



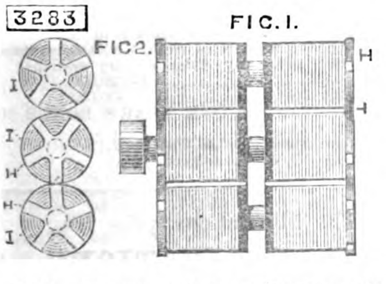
shunt brake, C, the escapement being arranged with a recoil action giving falls of precise mea-



sure to the carbon. A second form is a modified clutch lamp, in which a cone clutch, A, is fixed to and forms part of an armature, B, actuated by magnets C C.

3283. IMPROVEMENTS IN ELECTRIC GENERATORS, *S. Pitt, Sutton.—26th July*, 1881.—(*A communication from S. J. M. Bear, Mitchell, Iowa, U.S.A.*) 8*d*.

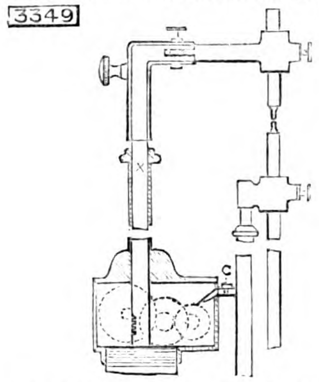
The object of this invention is to construct a machine in which the poles of the armature and the field magnets may be brought into the closest proximity, or even absolute contact with each other, without lessening its efficiency. Figs. 1 and 2 show a machine of this kind, the three straight electro-magnets, having their cores parallel. These cores are provided with polar exten



sions H H. The spaces between H H are filled with non-magnetic material I I, to complete a solid disc at each end of each of the magnets. The magnets are assumed to be mounted in a frame, so as to allow the revolution of each magnet about an axis concentric with its core, with the solid polar discs at their extremities either in actual contact or close proximity. Fig. 2 shows the angular position of H H with reference to each other. Various modifications of this machine are described.

3349. IMPROVEMENTS IN ELECTRIC LAMPS, *A. W. L. Reddie, London.—2nd August*, 1881.—(*A communication from D. A. Chertemps, Paris.*)—6*d*.

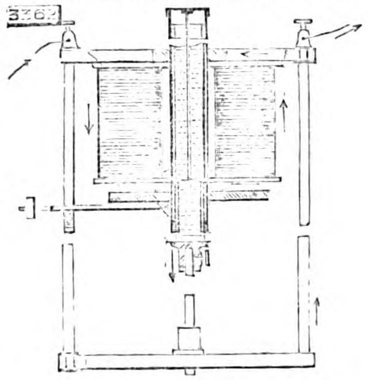
The construction of the lamp will be seen from the figure. The arc is formed by the lower carbon holder being drawn down by a solenoid not shown; spring pawl G will then arrest the motion of the



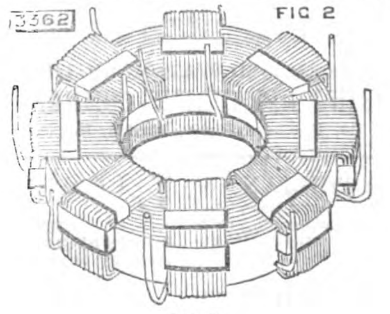
clockwork until again set free, when the rack rod X will be free to descend and bring the carbons into contact. The two screws shown permit of the adjustment of the upper carbon sideways, and also of the regulation of the arc.

3362. IMPROVEMENTS IN ELECTRIC LAMPS, &c., *J. Hopkinson, F.R.S., London.—3rd August*, 1881. 6*d*.

The upper carbon is carried from the armature of an electro-magnet, not rigidly, but by means of a catch, which, when the arc becomes too long, is



liberated by the action of the armature. The motion of the carbon is controlled by the fluid contained in the upper carbon holder. Fig. 1 explains the construction of the lamp, the arrows



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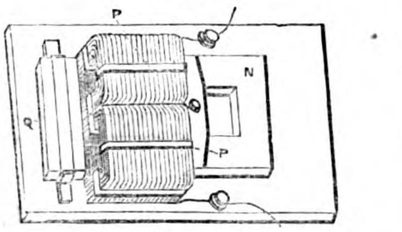
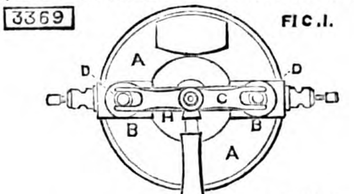
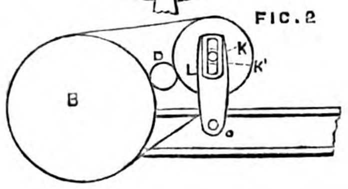


representing the direction of the current. The inventor also regulates the current supplied to any lamps by an adjustable self-induction coil. Fig. 2 shows one form of this coil. A ribbon of thin sheet iron is coiled into an annular form, there being a layer of insulating material between the overlapping portions or layers. Round this ring copper wire is coiled as shown. These coils are connected with plates, into which contact plugs connected with the main wires can be inserted, so as to place one or more coils in circuit. The ring may be cut in half in order to be able to place the copper coils in it, and subsequently joined. Fig 3 shows another form of this current regulator. The action is as follows:—When electro-magnet N is drawn from coils P and is at a distance from armature Q, the coefficient of self-induction is small, and as it is thrust in and approaches the armature the said coefficient increases. If a lamp be in circuit the current through lamp is diminished as N is thrust into the coils of P.

3369. WORKING GEAR AND APPLIANCES USED IN ELECTRIC LIGHTING, *K. W. Hedges, Westminster.—23rd August*, 1881. 6*d*.

This invention relates to such things as switches and driving gear. The switch, Fig. 1, is fitted between the contact pieces by insulating material A A, and from the end of the lever a loose con-

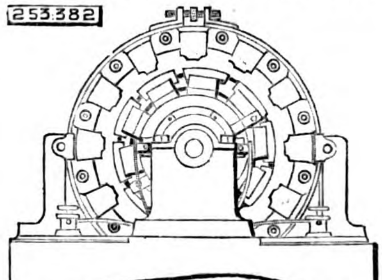




tact piece D, which can be moved as it wears the contact piece B. Fig. 2 shows the arrangement for driving the shaft of machines, where B is driving pulley, D that on machine, and L an idle pulley on spindle K[1] on block K.

253,382. MAGNETO-ELECTRIC MACHINE, *Ludwig Herman, Union, N.J., assignor to himself and Julius Jonson, New York, N.Y.—Filed May 13th*, 1880.

Brief.—An armature mounted on an excentric driving shaft is brought in contact with or in close proximity to the field-of-force magnets. The magnets are parallel with the shaft, and the entire body of the armature is wound with conducting



wires in the direction of rotation. Pole pieces are provided at the ends and in the centres of armature and field-of-force magnets. The electrical connections are such that the field magnets at one side of the point of nearest approach of the armature are of one polarity and those on the other side of the opposite polarity at all times.

255,497. INCANDESCENT ELECTRIC LAMP, *Phillip H. Diehl, Elizabeth, N.J.—Filed January 10th*, 1882.

Claim.—(1) An electric lamp consisting of a hermetically-closed glass globe, a light-giving part inside of the globe, a secondary coil supported within the globe and placed in circuit with the light-giving part, and a primary coil arranged exterior to said globe and in inductive relation to the secondary coil, substantially as set forth. (2) The combination of a glass globe containing the light-giving part, an extension made integral therewith, and secondary coil supported at the interior of the extension and placed in circuit with the light-giving part, and of a primary coil arranged exterior to the globe and in inductive relation to the secondary coil, substantially as specified.

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Incorporated the 28th March, 1872, under the Companies Acts of 1862 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

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Not having any springs or clockwork to wind up or to depend on, these instruments are acknowledged by those familiar with the system of telegraphy to be the only instruments yet invented that are capable of doing the work required of them continuously for a lengthened period, as evidenced by the fact that the Gold and Stock Company of New York, having the monopoly of this kind of business in the States, and which owns all the patents of the day of any value, has, after due trial, discarded all others.

The Company is prepared to treat with provincial Companies requiring instruments for the delivery of news for either single or double wire systems under the Company's patents, whereby from central stations identical information can be simultaneously delivered to any number of recipients by automatic, self-adjusting, printing instruments requiring no local batteries, no winding up, and no knowledge of telegraphy on the part of the receiver, the printing being in bold roman type, and the propulsion of the paper being effected by the electricity supplied from the Central Office.

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SLIP

Cable Interrupted.—The Great Northern Telegraph Company announce that their Amoy-Shanghai cable is interrupted.

Brazilian Submarine Telegraph Company. — The traffic receipts of this company for the five weeks ended May 26 amounted to £14,561.

Electric Light for Portsmouth.—It is stated that arrangements are being made for testing the electric light in some of the principal thoroughfares of this town.

Electric Light for Kensington.—The Kensington Vestry have appointed a sub-committee to consider the question of introducing the electric light into the parish.

Cable Repaired.—The Brazilian Submarine Telegraph Company's St. Vincent-Pernambuco cable, which was found to be interrupted towards the latter end of last week, has been repaired, thus restoring communication with South America.

Western Brazilian Cables Repaired.—The Western Brazilian Telegraph Company notify the repair of the Bahia-Rio de Janeiro section of their cables, and with this repair their whole system between Para and Montevideo is now in perfect working order.

The Swan Lamp.—We hear that the Swan Electric Light Company, of Newcastle-on-Tyne, have received an order to erect their lamps in Blagdon Hall, the seat of Sir M. W. Ridley, Bart., M.P. Blagdon Hall is situate, we believe, near Newcastle.

Electric Light at Bedford.—The Bedford Domestic, Artistic, and Scientific Exhibition, which opens on the 6th June, will be lighted with Brush arc lamps, for which a contract has been made with the Provincial (Brush) Electric Light and Power Company (Limited).

Electric Light in a Salt Mine.—The Witton Hall Salt Mine in Warrington-road, Northwich, is now lighted up by Brush lamps in place of the candles generally used. There are sixteen large arc lamps employed. The lights were erected by the Hammond Company, of Dale-street, Liverpool.

Cable Ship "G. E. Wood."—The India Rubber, Gutta Percha, and Telegraph Works Company have received a telegram from Mr. H. Benest from Galveston, announcing the safe arrival of the ss. "G. E. Wood" at that place on the 25th May. She will proceed at once to the laying of the cable she carries.

Underground Wires in New York.—The sub-committee appointed at Albany to report upon the practicability and feasibility of laying wires underground in cities in New York State have made a report in which they strongly urge the Legislature to pass a law compelling telegraph and telephone wires to be run underground.

South African Telegraphs.—The revenue receipts from the telegraphs in Cape Colony for the month ended March 31, 1882, were £5,686, against £5,402 in the same month of last year, or an increase of £284. For the quarters ended same date the figures were respectively as follow:—1882, £15,238, and 1881, £14,274, or an increase of £964.

The Worcestershire Exhibition.—The city sheriff of Worcester, Mr. Goodwin, having offered to place sufficient engine power at the disposal of the committee of this exhibition for electric lighting purposes without any further charge than engineman's wages, the hon secretary has been authorised to negotiate with the Hammond Company to supply the Brush light for four months, at a cost not exceeding £200.

Crystal Palace Electrical Exhibition.—We understand that it is probable that this Exhibition may remain open for a further period, the management having sent out circulars requesting the exhibitors to keep their stalls open for another three months. We believe that the replies to these circulars have in most cases been satisfactory, and that a good majority of the stands will remain open for the above period.

SS. "International."—The ss. "International," belonging to the India Rubber, Gutta Percha, &c., Works Company, arrived at Kingston, Jamaica, on the 25th May. She will coal there, and then proceed to complete the Galveston-Tampico section of the Mexican Telegraph Company's cables. Mr. Theophilus Smith joins the "International" at Kingston with Mr. J. Rymer Jones, and takes charge of the expedition.

International Electrical Exhibition at Vienna.—The General Committee of this Exhibition held a meeting on the 25th May, when it was proposed and carried that the Electrical Exhibition should be postponed until March or April, 1883. This alteration has been brought about owing to the Viennese manufacturers having promised to exhibit at Munich, Trieste, or Nuremburg before the date of the Vienna Exhibition was decided upon.

The Jablochkoff Light in Paris.—The Compagnie Générale d'Electricité announce that the Jablochkoff light has only been temporarily discontinued in the Avenue de L'Opera at Paris, owing to a re-arrangement of the works. The Municipality have renewed the company's contract for lighting the avenue for another three years, and have also given them power to introduce the light into the houses in the district served by their mains.

Edison Lamps in Brussels.—We are informed that the Edison incandescent lights, as fitted up in the restaurant and dining rooms of the Musee du Nord at Brussels, have proved entirely satisfactory, and fully meet the expectations of the management and public. It is now proposed to increase the plant to twice its present capacity, which consists of one dynamo and 120 lamps of one carcel intensity. Mr. E. G. Acheson is the engineer in charge of the work.

Tenders Wanted for Electric Lighting.—The Camberwell Vestry are inviting tenders for lighting a portion of their parish by electricity as an experiment. Further particulars, with specification, &c., can be obtained at the surveyor's office, Vestry Hall, Peckham-road, S.E. Tenders are to be sent in sealed, and endorsed "Tender for Electric Lighting," and delivered at the Vestry Hall by 5 p.m. on the 12th June, on which day the general purposes committee of the above vestry will meet to consider them.

Charing-cross Electric Railway.—The Charing-cross and Waterloo Electric Railway Bill, which passed unopposed through the House of Commons, has been stopped in its passage through the House of Lords, the examiners having reported that the standing order of the House applicable to this Bill has not been complied with. The Bill has, therefore, been referred to the Standing Orders Committee, which was to meet yesterday (Friday) the 2nd of June, for them to decide whether the Bill should be allowed to proceed.

The Hickley Telephone.—In the High Court of Justice on May 25, before Mr. Justice Fry, Mr. Cozens-Hardy, Q.C., with Mr. Moulton, applied on behalf of the United Telephone Company for an interim injunction to restrain Messrs. Orme, engineers, of 65, Barbican, from selling Hickley tele-

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phone receivers—which were held by his lordship in the action against Messrs. Harrison, Cox-Walker, and Co. to infringe the patent the plaintiffs hold for Bell's telephone—until the hearing of the case of the United Telephone Company *v.* Orme and Co. The injunction was granted.

Magnetic Properties of Steel and Iron.—Mr. L. M. Cheesman sums up the result of his investigations into the effect produced by the mechanical hardening of iron and steel on their magnetic properties in a paper contributed to the *Annalen der Physik and Chemie* as follows:—"Iron in a mechanically hard condition can receive more permanent magnetism than in a soft condition. The magnetic moment of a steel magnet in a mechanically hard condition is greater than in a soft condition, according as the ratio of its diameter to its length is less or greater than a certain limit."

Private Electric Lighting Bills.—The Select Committee on Electric Lighting have resolved to recommend to the House that all the clauses asking for powers to supply electric light be struck out of all the private Bills this Session. The Committee have likewise come to several conclusions as to the regulations to be applied to the supply of electricity for lighting purposes, which they have drawn up in the shape of resolutions. They are given in another column. It is understood that these will be incorporated as amendments of the Government Bill. The Committee have adjourned until Thursday, June 8th.

Thunderstorm in Paris.—The Paris correspondent of the *Standard*, describing a heavy thunderstorm which occurred early on Monday morning in Paris and the neighbourhood, says:—"Houses in the Grande Rue de Passy and in the Rue de Boulainvilliers were struck by the lightning. Severe storms and heavy showers are reported from different parts of the country, particularly from Pontoise and Chatellerault. In the latter place the walls of several houses were destroyed by the lightning, and the cellars were inundated by the torrents of rain. For two hours the thunder never ceased, and 1,200 flashes of lightning were counted within that period."

Patents.—The Commissioners of Patents have just issued two volumes of abridgments relating to electricity. The first includes all the specifications having reference to electro deposition and electrolysis from the earliest period down to the end of the year 1876. A very liberal scope is given to the words, so as to include methods of protecting ships' sheathing where electricity is supposed to come into play, as well as a number of eccentric patents for purifying and extracting metals by the aid of voltaic currents. The other volume relates to the generation of electricity and magnetism, and deals with the patents from 1867 to 1876 inclusive, the earlier years being included in a volume issued some time back.

Electric Meters.—In *La Lumière Electrique* for the 27th May, M. Marcel Deprez contributes an article on these meters, in which he gives extracts from his writings on this subject. He charges both Mr. Vernon Boys and Messrs. Ayrton and Perry with having reproduced his ideas and utilised the information contained in his writings in the construction of their respective instruments for measuring electricity without having credited him with the invention. He also asserts that Mr. Boys has adopted the form of integrater invented by M. Abdank-Abakanowicz. In the present article M. Deprez describes his own instrument with illustrations, and reproduces the description of Mr. Boys's meter, as given in *The Electrician* of recent date; he also announces his intention of describing and illustrating the integrater of M. Abdank-Abakanowicz in a future article.

Telegraphic Communication between Reigate and Redhill.—In the House of Commons on Thursday week Mr. Freshfield asked the Postmaster-General if his attention had been directed to the very imperfect and unsatisfactory telegraphic arrangements between the towns of Reigate and Redhill in Surrey. Those places were less than two miles apart, and contained 8,000 and 10,000 inhabitants respectively; they used until lately to be united by a wire, but now all messages between them and the surrounding populous towns and villages had to make a circuit of fifty miles, and were subject to much delay and uncertainty, having to pass through a busy London office; and whether he would cause measures to be taken to remedy this evil.—Mr. Fawcett stated, in reply, that it had been decided to make certain improvements, under which Reigate would have communication with Redhill by a direct wire.

Society of Telegraph Engineers and of Electricians.—The council have determined that this society shall offer three premiums annually for the best original paper sent in to the society on telegraphic or electrical subjects during the session by any person not being a member of the council of the society. The first premium will be called the Society's Premium, and have a value of £10; the second, the Paris Electrical Exhibition Premium, value £5; and the third, the Fahie Premium, value £5. The awarding of the premiums will rest with the council, to whom power is reserved of declining to award either or any of the said premiums in any year in which they may consider the papers offered as unworthy of the distinction. The premiums will consist of books or scientific apparatus. No person will be entitled to receive more than one of the said premiums in any one year. The first premiums will be awarded in 1883 for the best papers sent in between this date and the end of May next.

Legal.—Seaver v. Philippart.—This was an action brought in the Chancery Division of the High Court of Justice on Friday, the 26th May, by Mr. F. I. Ricarde Seaver in order to obtain an injunction to restrain the Faure Electric Accumulator Company from issuing to M. Simon Philippart, or to a Belgian Company called La Force et la Lumière, any share in the Faure Company, and to restrain Philippart and the Belgian Company frrom dealing with any of such shares or taking the certificates for the same out of the jurisdiction, and in order to obtain payment of a commission of 5 per cent. upon the net profits in cash or in shares of the Belgian Company in launching the Faure Company, to which commission the plaintiff alleged himself to be entitled under an agreement made on April 6th, 1882, between himself and the Belgian Company.—Vice-Chancellor Hall made an order for an injunction in these terms extending over the first motion day in the next sittings, directing the plaintiff to give the usual undertaking as to damages, and giving the defendants leave to move on short notice to dissolve the injunction.

New Companies.—The following new companies have been started since our last issue, viz.:—The British Indian Electric Light and Power Company (Limited), with a capital of £250,000. It has been formed to work throughout India the patents and systems owned by the Electric Light and Power Generator Company, including the Weston, Rapieff, Lontin, and Maxim machines and lamps.—The Continental Electric Light and Power Corporation (Limited) has been formed to purchase Gülcher's patents for the supply of the electric light and power in France, Austria-Hungary, Belgium, and Germany. The capital is £400,000.—The Self-Generating Electric Light and Power Company (Limited) has a capital of £300,000, and is formed to acquire the in-

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vention of Mr. R. H. Simons, for the production of electricity by a self-generating process, and also to work his incandescent lamp. The prospectus does not say how or by what means it accomplishes the "self-generating process," and justifies its title.—The Laing Electric Light and Power Company has a capital of £1,000,000, and has been formed to work Mr. Laing's system of arc lighting.

Overhead Telephone Wires.—The case of Twigg *v.* the British and Irish Telephone and Electric Works Company was heard recently before Mr. Justice Bowen. The action was brought to recover compensation for injuries arising from the fall of a chimney under the following circumstances:—The plaintiff, Mr. George Twigg, is a clipping machine manufacturer, at Birmingham, and alleged that he allowed the defendants to attach a wire to his chimney-stack, under an indemnity that they would pay for any damage which might result in consequence. On the 14th of October, 1881, during a heavy storm of wind, the wire gave way upon one side of the chimney, and subsequently the chimney-stack fell, and caused serious injury to the plaintiff's property. The plaintiff, therefore, claimed compensation. The defendants, on the other hand, alleged that the chimney was of such a weak construction that it would have fallen if the wire had not been attached, and that the wind was the sole cause of the accident.—The jury gave a verdict for the defendants upon the ground that the wire was not the cause of the chimney falling, and judgment was given accordingly.

A New Electric Lamp.—The *Operator* is responsible for the following:—"Mr. Henry Goebel gave an exhibition of his electric light, on the night of the 30th ult., in a room back of his store at 468, Grand-street, New York. Mr. Goebel claims that he has been at work on electric lights for thirty-one years, and that twenty-nine years ago he arranged one on the top of his house at 271½, Monroe-street. The light was seen from the Essex Market bell-tower and an alarm of fire was given, which brought out a number of engines. He himself was arrested, but Judge George Woods released him. When he returned home he found that his neighbours had demolished all his instruments and apparatus. The light exhibited recently was clear and steady, and one could read by it with great comfort and ease. It is about eight inches long and about as thick as a candle. The vacuum is obtained by a pump similar in principle to the Gessler pump, and can be operated by unskilled hands. The carbon points used are made of reeds, which are heated in the retort by electricity. The lamps cost 25 cents. apiece, and Mr. Goebel claims that he can furnish a light as cheap, if not cheaper, than gas."

Awards to Telegraph Messengers.—On Saturday last Mr. S. Walliker, Postmaster of the Birmingham Post Office, presented a certain number of the telegraph messengers with the certificates of merit earned by them during the last six months for celerity in the delivery of telegrams. This "merit system," as it is called, was inaugurated by the Postmaster six months ago, with the view of effecting the quickest possible delivery of telegrams. Under the system, the time of giving the message to the boy is entered, and a similar entry is made on his return (sufficient time being allowed for the various distances), and if the allotted time is exceeded, an explanation is called for. Every minute a boy loses is recorded, and the boy who loses the fewest wins the highest place. The places gained are exhibited weekly, and constant emulation is excited. "The results of the system," says the *Birmingham Daily Post*, "are shown by the facts that whilst during the first week, some eight months ago, the average delay per boy above the allotted time was seventeen minutes per day, the average delay for the entire week just ended was a little under five minutes for the week. One boy has worked thirteen weeks with a total loss of only two minutes."

The Patent Laws.—Mr. H. T. Wood, secretary to the Society of Arts, writes to *The Times* of 25th May, referring to the article on the present state of the patent laws, from which we gave a short extract in our last week's issue, and calling attention to the fact that the Society of Arts Patent Bill, now before the House of Commons, and which was read a second time a month ago, provides a remedy for some of the defects described in the article referred to. Mr. Wood says:—"It (the Bill) provides for an examination, not, indeed, into the merits or utility of an invention, but into the way in which the invention is described in the specification. It reduces the fees in the initial stages to a third of the existing amount; and it provides for the trial of patent cases by skilled Commissioners of Patents, acting as arbitrators, or by a Judge having these Commissioners sitting by him as assessors. Had our Bill been law last week, Edison's patent could not have been upset on the purely technical point that he had included in his provisional specification a certain invention which in his final specification he did not proceed with. Such a defect would have been discovered before the grant of the patent and set right; while even had it not been so set right, the defendant would have been expressly debarred from setting it up as his defence."

The Postmaster-General and the Telegraphists.—Mr. Macliver, M.P., has written a letter to the Postmaster-General, in which he says that his experience leads him to the conclusion that the retention of efficient telegraphists is a matter of great public importance. "It is to be feared," he thinks, "that if the dissatisfaction which continues to prevail among the best class of telegraphists be permitted to continue, the Post Office will ultimately lose the services of many highly-trained men, who might be retained without incurring any large expenditure. Among the 6,000 telegraph clerks in the United Kingdom there are from 600 to 700 pre-transfer men, whose claims to special consideration are worthy of careful examination. I believe that the utmost these pre-transfer men have asked for is to be placed on the same conditions as Post Office clerks. I have been requested to bring this matter before you, and I do so on public grounds, believing that the satisfaction of the claims of the pre-transfer telegraphists—who joined the Post Office under distinct promises—would prove advantageous to the public, and especially to all who have occasion in their business to make use of the telegraph to a large extent." To this Mr. Fawcett has replied that he has spared no pains to discriminate between the "legitimate and illegitimate claims of the telegraphists," and that although he knows that no arrangement can be devised which would satisfy everybody, he feels confident that the settlement of last year fully meets the justice of the case. He concludes, "Under these circumstances I cannot consent to re-open the question. I believe there is no ground for the fear you express that the department will lose the services of many of the best telegraphists, as in several instances telegraphists who have lately left have earnestly entreated to be permitted to re-enter the service."

The Telephone Case.—Mr. Hunning writes to *The Times* on the subject of his telephone as follows:—"The means I employ in the transmission of speech is the vibration of visible grains of the hardest and lightest oven-made engine coke, no dust or impalpable powder being mixed with them. If any compression in the shape of a 'tension-regulator,' as described in the Edison patent, is applied to my in-

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vention, it becomes useless as a telephone transmitter. I cannot venture to trespass upon your space further, but conclude by saying that I verily believe my invention is a distinct invention from Edison's, and in no way can be called 'a tension-regulator.' If any tension is applied to my free grains of oven-made engine coke or to the free grains of any other good conductor, you prevent their free rubbing together, and come back to a worse transmitter than the Bell telephone." Mr. J. Munro writes:—"In the Rev. Dr. Hunning's letter the 'tension-regulator' of Edison's patent is spoken of as if the word 'tension' meant mechanical stress, whereas it has been held by the Court, and by the experts engaged, to mean intensity or strength of current. Tension is a discarded electrical term, once vaguely used to mean electromotive force, and sometimes, also, intensity of current. A tension-regulator thus becomes a strength of current regulator. This correction, however, leaves Mr. Hunning's position as good as before, for in the same sense a Reis transmitter and a microphone are 'tension-regulators.'" With regard to Edison's phonograph and the apparent clashing between the judgments of Lord Maclaren in the Edinburgh Court and the more recent one of Mr. Justice Fry, Mr. Munro points out that "Lord Maclaren had only to decide whether a single phrase in the provisional specification indicated the phonograph or not; whereas Mr. Justice Fry had to consider the far more fatal objection that a non-electrical instrument (the phonograph) was claimed in a patent for transmitting speech electrically, without any connection with the purpose of the patent having been expressed in the claim."

Experiments with the Electric Arc in Vacuo.—MM. Jamin and G. Maneuvrier communicated a note to a recent meeting of the French Academy of Sciences describing the following experiments with the electric arc in vacuo, the current being supplied by a Gramme dynamo machine:—"Having taken an egg-shaped glass tube and placed in it two carbons of ·15 metre length and 4 millimetres diameter, arranged point to point, and separated by an interval of 4 millimetres, when the vacuum had attained about 12 millimetres light began to break forth, not only in the form of a highly luminous arc between the carbon points, but from all parts of the carbons, and similar in appearance to that ordinarily seen in Geissler tubes. Each carbon was surrounded by a blue aureola, that of the positive carbon being the paler. The carbons subsequently became heated, reddened, and then got white hot, not only at their ends but throughout their length; they were then rapidly volatilised by the combined effect of the heating and the electrical currents. Whatever be the cause of this volatilisation it is certain that carbonaceous matter is given off in a vaporous state. The vessel or tube is filled with a blue gas somewhat similar to the vapour of iodide, which gradually deepens to the colour of indigo. After this the vapours are condensed on the sides of the vessel, which become opaque, and this ends the experiment. The deposit thus collected resembles finely-divided carbon, and dissolves with effervescence and incandescence in nitric (*azotique*) acid. Is it pure carbon, or is it a composition of hydrogen and carbon? This is a question which I reserve for further experiments. To avoid this summary termination of the experiment, I replaced the single carbons by two bundles of similar carbons. In this case the currents divided into a large number of flows, less intense than the single flow; all the carbons gave light at the same time, and heated the less the more numerous they were. There was hardly any volatilisation, and the effect was prolonged as long as one wished. I replaced the carbons by copper rods ·003 metre diameter. The same effect was produced with still greater success. If the current was too strong the copper melted. It always partly volatilised, and was deposited in a thin layer on the glass. It is plain that the experiment can be varied by using different metals, different gases, and by operating under different pressures."

Underground Wires.—In a letter to the Philadelphia *Times* of May 18, Mr. David Brooks deals with the question of underground wires, particularly referring to electric light conductors. It appears that a Bill is now before the council of the city, the object of which is to give permission to electric light companies to erect poles for their wires, and Mr. Brooks points out that the objections to overhead electric light wires are even stronger than to overhead telegraph or telephone wires. We make the following extracts from his letter:—"To compel the telegraph and telephone companies to place their wires under ground would put those companies to great expense. When such change is made it must be gradual. How much easier it will be for the electric light wires to be placed under ground in the first place than to make a change after they have an expensive plant of poles and overhead wires. Much is said of the Brush Company for having lighted Chestnut-street free of cost. So far as I can learn they have marred the appearance of the street by day more than their lights have improved it by night. Not in all the lanes and by-ways of the United Kingdom of Great Britain can be seen so ungainly, unsightly telegraph poles as are now seen from my front window on Chestnut-street. The Jablochkoff Company of Paris lighted the Avenue de l'Opera for a long time free of cost; they have far many more lights on that avenue than are now placed in Chestnut-street. The conductors were laid directly under the asphalte pavement near the curb, convenient to be attached to the conductors inside the lamp-post. No conducting wires are seen outside of the lamp-post. This makes it easy to have a lamp post of symmetrical proportion. The lamp-posts in Avenue de l'Opera are ornamental. Is there anything to admire in the form of these post on Chestnut-street as compared to the old gas lamp-posts? The Anglo-American Brush Company and the British Electric Light Company have each lighted portions of London free of cost. All their conductors were placed underground. The Thames Embankment, together with Waterloo and Westminster Bridges and the vicinity of Westminster are most beautifully lighted by the Jablockkoff and Brush lamps, and not a wire to be seen. Telegraph and telephone lines have become in a measure a necessity. The change from overhead to underground cannot be made without inconvenience to the public. In that respect electric lighting may be considered more like a luxury. They are not needed, or certainly not a necessity. The Edison Company, of New York, appear to have commenced right. They have now ten miles of pipe laid containing electrical conductors. The insulation is carefully tested from day to day, with quite satisfactory results. All of the systems now in use in Europe are available for companies in this country, and nothing but an inordinate desire to make quick fortunes prevents their use. One of these companies state they have twenty millions of dollars to carry on this work. I should judge they saw twenty millions before them within easy grasp provided this Bill should pass. One councilman stated that the town of Albany, with forty thousand inhabitants, had more electric lights than Philadelphia. He should have added that the citizens of Albany are praying the Legislature for relief from poles and conductors."

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THEORY OF MAGNETO AND DYNAMO MACHINES.

XIV.

We have now proved conclusively, what is abundantly confirmed by experiment, that currents are induced in every conductor moving in a magnetic field in such a way that the number of lines of force passing through it varies; and that the electromotive force urging these currents is precisely equal to the rate of change in the number of these lines of force, or the number added or subtracted every second from the area enclosed by the conductor.

So to generate currents in a brass curtain ring it is only necessary to spin it on the table. There are reverse currents at every half revolution, and their strength was investigated last week. Currents flow round a finger ring every time the wearer moves his hand. Let us take a numerical example to show that, though the E.M.F. produced by the feeble magnetic field of the earth is but slight, yet in a massive conductor of low resistance the currents produced are not insignificant.

Take a ring of copper 8 inches or 20 centimetres in mean diameter, and with a cross section of half a square inch or 3 square centimetres (weighing, therefore, a little over 3 lbs.), and spin it about a horizontal east and west axis n times a second. It will cut all the earth's lines of force which pass through it four times in every revolution, for they are taken out in two of the quadrants and put in in the other two.

The total intensity of the earth field is ·46, or ·46 lines of force pass through every square centimetre normal to the dip; hence the total number passing through the ring is $\cdot 46\,\pi\,r^2 = 46\,\pi$. In every revolution all these lines are cut four times, and it makes n revolutions in a second; hence the average E.M.F. acting is $184\,\pi\,n$.

The current depends upon this and the resistance. Now the resistance of the ring is the circumference divided by the sectional area, viz., $\frac{20\,\pi}{3}$, multiplied by the specific resistance of copper, viz., 1710; so it comes out $11400\,\pi$ centimetres per second. The average current during the rotation is, therefore, $\frac{184 n}{11400}$ C.-G.-S. units.

Let us put these into practical units, on the supposition that the ring makes 1200 turns a minute—that is, if $n = 20$.

The E.M.F. is only ·000115 of a volt; but, as the resistance is but ·0000354 of an ohm, the current is 3·28 amperes.

The power that must be expended to drive the ring against the electrical forces, over and above friction, is $E\gamma = \gamma^2 R = \frac{E^2}{R}$ (whichever expression is preferred), viz., $\frac{(184 n)^2 \pi}{11400}$, or 3712 ergs per second, which is only half-a-millionth of a horse-power. The heat generated per second in the ring will be ·0000888 of a thermal unit, so it would have to spin for ten hours before enough heat was generated to raise 3 grammes of water 1 degree Centigrade; and the rise of temperature of the ring would only be a degree in three weeks, even if there were no cooling.

But then remember that the ring is spinning, as many things spin, simply in the ordinary space near the earth, in the exceedingly weak magnetic field of intensity ·46. But if it were spun between the poles of a magnet, the field in which it was might easily have the strength 460, or perhaps even 4600, and then we should have a very different state of things.

Thus, to take the more moderate case, let the field in which the ring is spinning 1200 times a minute be 1000 times as strong as the earth's; that is, let it have 460 lines to the square centimetre. The average strength of the induced current would then be 3270 amperes, the power required to turn the ring would be half a horse-power, and the heat generated 88·8 thermal units per second. The temperature of the copper ring (whose thermal capacity about equals 150 grammes of water) would, therefore, rise more than half a degree every second at first, *i.e.*, until it got distinctly hotter than the atmosphere. In about a minute it would probably have run up about 20 degrees, and it would not cease to rise until it got so much hotter than the air that it was able to pour out 90 heat units every second, or 16 units a minute from every square centimetre of its surface.

We have taken a ring as being very easy to apply arithmetic to, but there is no reason to take a perforated figure. A disc or a sphere would do as well, only it is not so easy to say what their effective resistance would be. But it is important to observe that a moving conductor acts in precisely the same way whether it is bounded by a non-conductor or not. In other words, a portion of a great mass of copper bounded by flow lines may be treated as if detached and surrounded only by air. A steadily spinning sphere is cutting lines of force just as effectively as a loop or ring.

Suppose, now, that instead of a massive ring we spin a coil of wire of the same size and weight, the size and weight of the insulating material being for the present left out of account; and suppose the coil to consist of N turns of wire, and to have its ends joined. The effective area, and, therefore, the E.M.F. generated, would be N times as great as before; the resistance would be N^2 times as great; and the current would be $\frac{1}{N}$th. But the power necessary to turn it in the magnetic field, and the heat generated, would be *precisely the same* as if the ring were solid—or as if the coils were detached parallel ones instead of a continuous spiral.

It may be as well at this point to put the matter into symbols for convenience of future reference. Let the ring contain a mass M of copper wire of specific resistance r, and density ρ; let D be the mean diameter of the ring, and let N be the number of turns of its wire; then, no matter what the thickness or weight of the insulating material between the turns of wire, it will be always very nearly true that the electrical resistance of the coil is

$$R = \frac{N^2 \pi^2 D^2 \rho r}{M};$$

and that, if the coil is spun, n times round a second, in a magnetic field of intensity I, the average numerical value of the induced electromotive force is

$$E = N I n \pi D^2,$$

and that the average strength of current (still paying no attention to sign) is

$$\gamma = \frac{n I M}{N \pi \rho r}.$$

The only approximation here made is that we have neglected the sluggishness or inertia of the electricity due to what is called *self*-induction; but this becomes important when the speed is excessive.

The power required to drive the ring against the magnetic forces is

$$\frac{I^2 n^2 M D^2}{\rho r},$$

and the heat generated per second is, of course, this same quantity divided by J.

We will next determine the E.M.F. developed when the contrivances of Arts. IV. and VIII. are rotated by hand. But it is very easy—it is merely finding $\frac{dN}{dt}$ for them. In the present article we have not troubled about the value of this quotient for the spinning ring in its different positions; we have simply taken its average value. Its actual value at any instant depends upon sin θ, being $I A \epsilon \sin \theta$, and is of no particular interest; but for the spinning machines of Art. VIII. its actual and average values coincide.

THE MAGAZINES.—Mr. W. H. Preece, F.R.S., continues his article on "The Age of Electricity" in *Time* for June. The present article deals with telegraphy.

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A CUPROUS CHLORIDE CELL.

BY A. P. LAURIE.

The cuprous chloride cell is a development from some experiments made on an iodine cell. The iodine cell consisted of a zinc plate and a carbon plate, immersed in a solution of iodine in iodide of zinc. A description of this cell was communicated by me to the Royal Society of Edinburgh about twelve months ago. Though it is a one fluid cell it does not suffer from polarisation, and consequently has a constant E.M.F.

There is a certain amount of local action in the cell, the zinc plate being dissolved in the iodine, and the zinc plate should, therefore, be removed from the cell when it is not being used.

This cell is evidently capable of being used as a secondary cell. On passing an electric current through it the iodide of zinc is decomposed, iodine being set free at the carbon plate, and zinc being deposited on the zinc plate.

It is not available as a secondary cell for practical purposes, as the closeness of the plates necessary in a powerful battery necessitates the use of a strong iodine solution, which acts very rapidly on the porous zinc deposit.

It is evidently necessary to attach the iodine to the carbon pole in an insoluble form, and, in searching about for some suitable compound of iodine, I devised the cuprous chloride cell.

This cell, like the last, may be used either as a primary or a secondary cell.

An uncharged cell consists of two copper plates immersed in a solution of chloride of zinc. On passing an electric current through the cell zinc is deposited on the one copper plate and chlorine separated at the other copper plate. The chlorine never appears as gas, it combines with the copper to form cuprous chloride, an insoluble white precipitate. The cell is now charged.

On connecting the two copper plates an electric current will flow from the one to the other until all the zinc deposit is reconverted into chloride of zinc, and the cuprous chloride is reduced to metallic copper. The cuprous chloride is held against the copper plate, and prevented from diffusing through the liquid to the zinc deposit by wrapping the copper plate in parchment paper. The E.M.F. of this cell is low, being ·75 volt, a Daniell being taken as 1 volt.

This is compensated for by its low internal resistance. While being charged no chlorine is given off. When the copper plate is completely coated with cuprous chloride the internal resistance of the cell rapidly increases. On now using the cell to supply a current it immediately returns to its normal low resistance. It will give out electricity but not take it in.

In a cell like the Faure, where the peroxide formed is a conductor, the cell indicates that it is completely charged by the copious evolution of gas. In the cuprous chloride cell, where the compound formed is a non conductor, no gas is given off, but the internal resistance increases. It is, therefore, necessary in the cuprous chloride cell, as in other secondary cells, to have a large surface at the negative pole. I find that I can prepare the best surface by the reduction of cuprous chloride paste. The copper plate, covered with a paste of cuprous chloride, and wrapped in parchment paper, is immersed in the chloride of zinc solution, along with a zinc plate. When the two plates are connected, an electric current flows from the one to the other, rapidly reducing the cuprous chloride to spongy copper. I sometimes cover the spongy copper with copper gauze in *metallic* connection with the copper plate, by solder, or otherwise. The copper gauze holds the spongy copper in position, and also makes a second surface of action for the chlorine.

The deposited copper is thus attacked by the chlorine both from the gauze inwards and the plate outwards. It is also useful in regulating the internal resistance of the cell.

I have used both upright plates and shallow copper trays, one inside another. The copper trays are the simplest possible form of cell, but present certain practical difficulties which I have not as yet surmounted. When used as a primary, this cell is very similar in principle to De La Rue's chloride of silver battery.

As a primary it has these two important qualifications :—

1st. There is no polarisation, and the E.M.F. is, therefore, constant.

2nd. There is no loss from diffusion of one liquid into another, as there is no second liquid to diffuse.

If in using it as a primary certain precautions were taken to prevent the oxidation of the cuprous chloride (it can be kept for months under water without any signs of oxidation), it should be a very durable and constant cell. I have not as yet tested its durability in this respect, but will do so very shortly.

THE TELEPHONE CASE.

The judgment of Mr. Justice Fry, as given in our last issue, was based upon the evidence given during the trial, evidence which we shall not attempt to reproduce *verbatim*, but merely abstract, giving what appears to be its main features.

Sir FREDERICK JOSEPH BRAMWELL said that for some years he had taken a scientific interest in telephony, and that as far as he knew before 1876 there was no instrument capable of transmitting articulate speech. He explained the action of the Bell telephone, both with electro and with permanent magnets, practically thus :—That the motion of the transmitting diaphragm creates a disturbance in the transmitting magnet field, and thus a current is induced in the coil; this current traverses the closed circuit, and hence the coil at the receiving end, when it acts on the magnet at the receiving end, disturbing its magnetic field, and producing a motion of the diaphragm there similar to the motion produced by the disturbing causes in the first instance. It was made clear in this part of the case that the charge against the defendants was "selling the Edison transmitter and the Bell receiver." Fig. 1 shows the ordinary Bell telephone :—

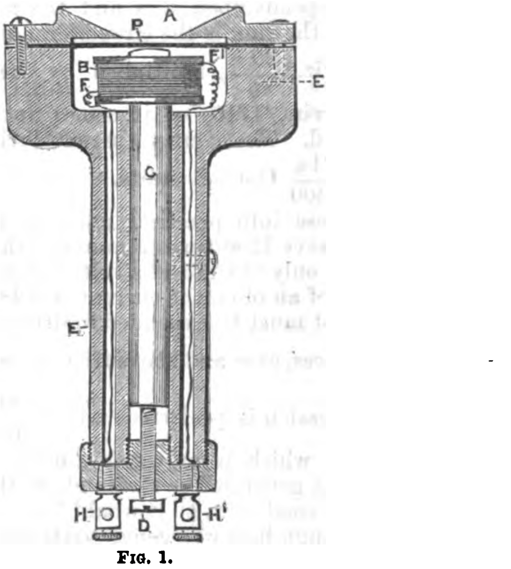

FIG. 1.

A permanent magnet, C, has a coil of wire, B, put round one end. In front of the magnet is a thin disc of iron P. When the iron is spoken to it vibrates freely to and from the magnet, but it affects the magnet by induction, altering the shape of the magnetic field, and so causing magnetic currents to cross the coils of insulated wire. The result is that electric currents are induced in the coil. These react on the magnet at the other end of the circuit through the wires F F', which connect to line wires through the terminals H H'. D is a regulating screw, A mouth-piece, E case. This is Bell's telephone, which requires no battery.

Various modifications have been suggested to increase the volume of sound obtained by using Bell's instrument as a transmitter, such as multiple magnets, large diaphragms, &c. The following extract from Bell's—Morgan-Brown's—specification, No. 4765, 1876, will make the points raised in this trial clear :—

"This invention relates to the reproduction by the necessary receiving instruments of any particular sounds or combinations of sounds through the agency of an electric current, whereby a multiplicity of telegraphic messages may be sent simultaneously over a single circuit in the same or in opposite directions, and received without confusion, and whereby articulate speech may be electrically transmitted. The invention relates to the production or

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transmission of musical notes by means of undulatory currents of electricity, one battery being used for the whole circuit, whereby two or more telegraphic signals or messages can be transmitted simultaneously over a single circuit in the same or in opposite directions. The invention also relates to the electrical production or transmission of sounds of every kind by means of undulatory currents of electricity, whereby not only musical sounds but articulate speech can be transmitted over a telegraph line, and two or more messages be simultaneously sent over a single circuit in the same or in opposite directions. The invention also relates to the electrical production or transmission of sounds of every kind without a battery by means of undulatory currents of electricity, whereby not only musical notes but articulate speech can be transmitted over a telegraph line, and two or more messages be sent simultaneously over a single circuit in the same or in opposite directions. The invention also relates to the automatic reception of signals or messages by introducing at the receiving end of the line a local circuit containing a vibratory circuit breaker, whereby telephonic signals or messages may be automatically recorded. The invention

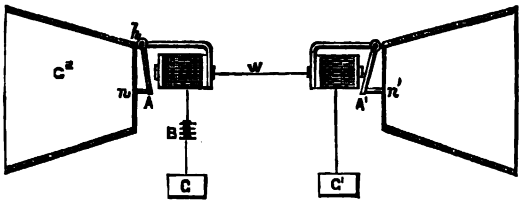

FIG. 2.

tion also relates to the application of electric telephony to autographic telegraphy, whereby characters or marks of any description may be copied in *fac-simile* at the receiving end of the line. In the first three plans described in this specification a separate instrument is employed for every pitch, and the electric vibrations for different pitches are combined upon the wire, each armature being capable of transmitting or receiving but a single note, and thus as many separate instruments are required as there are messages or musical notes to transmit. In the fourth part of the invention a single instrument is employed, the armature of which can be set in vibration by a musical instrument or by the tones of a human voice, or by any sound whatever. The telephones are illustrated in Figs. 2 and 3. One of the ways in which the armature may be set in vibration has been stated to be by wind. Another mode is shown in Fig. 2, whereby motion can be imparted to the armature by the human voice, or by means of a musical instrument, or by sounds of any kind. The armature A is fastened loosely by one extremity to the uncovered leg, *h*, of the electro-magnet E, Fig. 3, and its other extremity is attached to the centre of a stretched membrane, *n*. A cone, C², is used to converge sound vibrations upon the membrane. When a musical note is made in the neighbourhood of the membrane *n* it is set in vibration, the armature

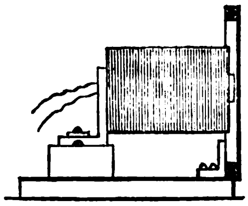

FIG. 3.

A is forced to partake of the motion, and thus electrical undulations are created upon the circuit G, B, E, W, E¹, G¹. The armature A¹ is thus thrown into synchronous vibration with the armature A, emitting a musical note of similar pitch to that which originated the vibration of armature A. If two or more musical notes be simultaneously sounded in the neighbourhood of the cone C², the resultant motion of the air is copied by the membrane *n* to which the armature A is attached, and this armature A, acting inductively upon the current traversing the coils of the electro-magnet E, occasions an increase and diminution in its intensity, and the armature A¹ is thrown into vibration by the varying attraction of the electro-magnet E¹ to which it is attached, and thus imparts to the air at n^1 a *fac simile* copy of the motion of the air that acted upon the membrane *n*. Hence two or more musical notes or telegraphic messages can be sent simultaneously along a single circuit from one station to another by means of one instrument at each station. Instead of the cone membrane and armature shown in Fig. 2, a plate of thin steel may be used; the vibrations of the plate in front of the magnet occasioned by the motion of the air during the production of sound changes the intensity of the current, and occasions a similar motion in a similar steel plate in front of another electro-magnet at another station in the circuit. Such a plate is shown in Fig. 3, it being attached to a frame. This invention is not limited, however, to the use of a steel plate, but includes within its scope any material capable of inductive action upon a current of electricity. In the telephone shown in Fig. 4 the magnet may be of the horseshoe form as shown at 24, and the coils of insulated wire 25 may surround soft iron cores or pole pieces, 26, screwed, or otherwise fastened to the ends of the magnet 24. The cores or pole pieces are placed near the face of the metallic plate A³, it being attached to a cup-shaped block, 28, having a central orifice, 29, for the reception of a speaking or hearing tube to convey sounds to or from the plate A³. The magnet is attached to a stud, 30, adapted to be moved in suitable grooves in the base 31 by means of a screw, 32, having its end connected with the stand, the body of the screw being fitted to turn in a screw-threaded stud. The movements of the

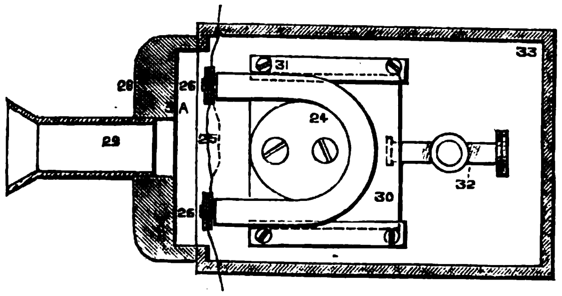

FIG. 4.

screw are just the distance between the pole of the magnet and the plate A³, and permit the poles to be placed almost in contact with the plate. The coils may be placed about the ends of the magnet 24, and the soft iron pole pieces be omitted. The coils will preferably be very thin, and be placed at the extremity or extremities of the magnet. One, two, or more magnetic poles with coils may be placed near a plate to intensify the effect. The soft iron core and coil may be attached to the plate instead of the magnet, or the core may be placed upon the plate, and the coil on the magnet, or *vice versâ*. The magnet may be made to vibrate instead of the plate."

The instrument of Bell giving such faint sounds when used as a transmitter great efforts were made to supersede it. And

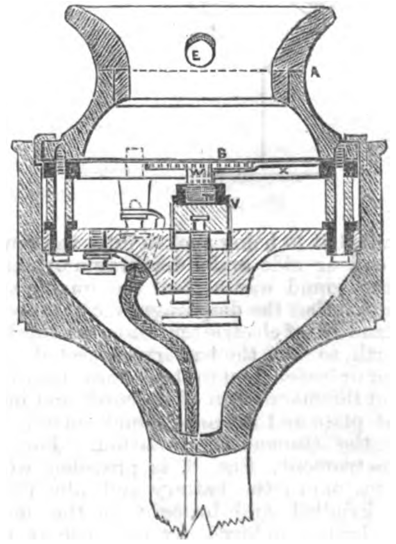

FIG. 5.

eventually different transmitters were used in conjunction with Bell's instrument as a receiver. One of these connected more especially with this case is Edison's transmitter. The action of this was described as follows:—"There being a battery to produce a current which is to go along the line wire to the receiving instrument there is at the transmitting end put in the circuit one of these tension devices of Edison. The tension device is made of something of semi-conductivity, lamp-black, plumbago, or of materials of an elastic character, which can be brought nearer together and will re-assert themselves when that which brought them nearer together is removed, and a tympan or diaphragm which need not be capable of inductive action—it may be of mica, for example—is caused to vibrate by the sound waves produced by the speaker, and in its vibration varies the

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pressure on the tension device, thereby possesses more or less resistance to the passage of the current, and in this way changes the force of the magnet, electro-magnet, or permanent magnet at the receiving end, so as to cause the plate there, which is capable of inductive action, to make similar vibrations to the plate, or diaphragm, at the transmitting end, that is to say that, unlike the Bell transmitter, where the voice of the speaker always had to generate what I will call the operative electricity, which in the first plan of Fig. 5 was the only electricity, in Edison the voice of the speaker has merely to modify electricity which is provided by the battery." It will be best now to refer to Edison's patent. His claims have reduced the claims to a mica diaphragm, the electric tension regulator, and the phonograph. The tension regulator is in the shape of a carbon button, or lozenge.

The following extract from Edison's patent, No. 2909, 1877, will make matters clear:—"This invention relates to that class of electrical instruments in which sound becomes one of the elements in the transmission of the communication, and the same sound is produced at the receiving station, so that oral communications can be sent by electricity and clearly distinguished at the receiving station. In my present invention I make use of the vibrations given to a diaphragm or tympan, by speaking into a resonant case, to produce a rise and fall of electrical tension upon the line with such accuracy that the electric pulsations or waves will represent the atmospheric sound waves produced by articulation, and the electro-magnet at the receiving station will respond to the electric waves in such a manner as to reproduce the articulation by acting upon a resonant plate. The instrument in a complete form is represented in Fig. 5, being a section of the transmitting instrument. The resonant tube or box A is of a

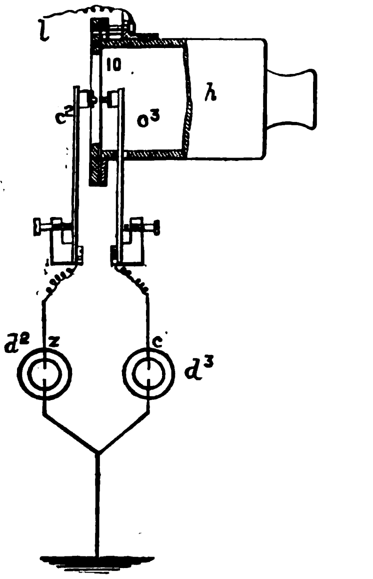

Fig. 6.

size and shape adapted to being spoken into, the same having an opening at one end or side and a diaphragm or diaphragms, B, against which the sound waves from the human voice act, and these and the motion that the diaphragm receives are the means of producing a rise and fall of electric tension on the line by the devices hereafter set forth, so that the battery connected to the line will transmit a greater or less current to the distant electro-magnet, and increase or lessen the magnetism of the cores, and in so doing act upon a resonant plate and develop sound corresponding to the articulation at the transmitting station. For convenience the speaking instrument, Fig. 6, is provided with a handle and flexible conductors to the battery and line respectively, so that it may be handled and brought to the mouth. Many materials have been employed by me, such as metals, horn, vellum, celluloid, ivory, &c., but almost all of these produce a prolonged or secondary vibration from their own resonant character. Hence the articulation is defective, and the sound vibrations blend. After extensive experiments I find that mica is almost entirely free from any resonant action, and hence it will respond with the greatest accuracy to the sound vibrations, and being of a laminated character can be employed of any desired thickness, and when secured at its edges responds with the greatest accuracy to the sound vibrations, and does not require to be strained; furthermore, the changes of temperature and atmospheric condition have little or no effect upon the mica diaphragm or tympan. I find that it is not practical to open and close the line circuits in instruments for transmitting the human voice; the circuit to the line must be always closed, and the transmission be produced by a rise and fall of electric tension, resulting from more or less resistance in the line. This resistance may be produced in several ways. I have shown several which will hereafter be named, but I find the most delicate to be small bunches or tufts, or discs of semi-conducting elastic fibre, such as particles of silk, and an intermediate conducting or semi-conducting material. This device I call an electric tension regulator; it is more or less compressed, according to the vibrations of the diaphragm or tympan, and the electric current rises in tension as it is compressed or lessens as the fibre expands. This fibre is placed in a small roll between a delicate diaphragm spring, and a variable presser, adjustible by screw or otherwise in the electric circuit at this point, or it may be within a cavity in said presser V, as in Fig. 6, there being a delicate cork centre piece, W, to the diaphragm B, with a piece of platina foil, X, in contact with the fibre. In all instances the telegraphic circuit at the diaphragm is made by a thin strip of platina or similar material extending to the centre from the line or battery connection. The fibre is rendered semi-conductive by being rubbed with plumbago, soft metal, or similar material, or by a deposit of metal upon its surface, or by fine particles of conducting or semi-conducting material mixed with it, the conducting power varying with the density of the tuft or bunch of fibre. I sometimes arrange the battery in connection with the transmitting instrument, as shown in Fig. 6. *h* is the resonant chamber, at the end of which is the diaphragm 10, and at each side of this diaphragm there are springs, c^2 c^3, having points made of compressed plumbago mixed preferably with gum rubber, but any substance not liable to rapid decomposition, or the elastic or fibrous tension regulator aforesaid may be used. These points face each other on opposite sides of the diaphragm, and make contact with platina foil discs secured to the diaphragm. The spring c^2 passes through a hole or small slot in the side of the chamber *h*. d^2 d^3 are the main batteries. The battery d^2 has zinc to the line or spring c^5, and the battery d^3 has copper to the line or spring c^3.

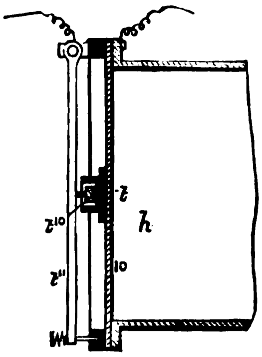
Fig. 7.

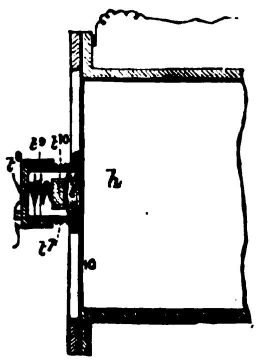
Fig. 8.

When the springs c^2 and c^3 are adjusted to make contact with the diaphragm equally, no current passes to the line; but when the diaphragm is vibrated its movement to one side, say c^2, causes a greater pressure upon the plumbago on that spring, and a lessening of the pressure on the plumbago on c^3; hence the balance of the batteries c^2 and c^3 will be destroyed, c^2, having the advantage, will send a negative current to line; upon the return of the diaphragm the battery currents will again neutralise each other. The vibration of the diaphragm to the other side causes the pressure to be reversed, and the battery d^3 will send a positive current to the line. As the tension regulator of fibre or of plumbago decreases and increases its resistance enormously under slight changes of pressure, it follows that the strength of the electric waves will be in proportion as the speaker's voice is strong or weak. For repeating from one circuit into another I use with the receiving diaphragm the elastic tension regulator Fig. 5 in addition to the electro-magnet, and connect the relay or second circuit through the same, so that waves received from the distant station cause the magnet to vibrate the diaphragm, and this acting upon the tension regulator transmits the waves into the second circuit, and they are received at the other end by an electro-magnet and diaphragm. By placing the fibrous tension regulator within a small band of india rubber the same is rendered more elastic, and the fibre is allowed to expand by the heat of the current without altering the electric tension. In cases where a strip of hard rubber or a cord of silk or other material coated with plumbago or metallic foil is introduced between the diaphragm and a rigid support, the expansion and contraction due to the passage of the electric currents will produce a movement upon the diaphragm corresponding to the diaphragm producing the electric pulsations. In some instances the diaphragm should be free to vibrate without being checked by contact with any stationary substance. I provide for this by placing upon the diaphragm or tympan 10, Fig. 7, a small cylinder l^7 of hard rubber or non-conducting material, within which is the

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fibrous tension regulator t resting upon a piece of platina foil connected to one pole of the battery, and within this cylinder t^7 is a disc t^{10} of iron or other metal, loose, but pressed towards the tension regulator by a spring t^8 and screw cap t^9, and the other electric conductor is connected with said spring. The inertia of the metal disc causes more or less compression of the tension regulator as the diaphragm is vibrated, and hence the electric pulsations are sent over the line in harmony with the vibrations. Nearly the same effect is produced by connecting the disc t^{10} to a yielding spring that extends across from one edge of the diaphragm to the other, as seen in Fig. 8. This construction of tension-regulating device is especially available with large diaphragms. In some cases I use a soft rubber diaphragm immediately in contact with the transmitting or receiving diaphragm, so as to check or dampen any prolonged or false vibration, and render the sound more clear and free from prolonged tones. In preparing the tension regulator I find in some cases that it is preferable to use lamp-black mixed with pure plumbago, amorphous phosphorus, and a very small amount of non-conducting material, such as rubber dissolved in a solvent that will entirely evaporate."

The difference between Bell's and Edison's plan of modifying the independent line current when both used electro magnets was stated to be that in one case you modify it by a current generated by the voice, in the other by increasing or diminishing the resistance of a portion of physical substance through which the current passes. Reis's work was thoroughly discussed, but so far as this case is concerned the evidence seemed to point out that its action is by an intermittent current, whereas Bell and Edison claim action by an undulatory current.

(TO BE CONTINUED.)

THE SUITABILITY OF DIFFERENT MATERIALS FOR TELEGRAPH AND TELEPHONE WIRES.

BY MESSRS. FELTEN AND GUILLEAUME.

1.—*Telegraph Wires.*

The stipulations as to the conductivity of telegraph wires, until now only made by English telegraph engineers, having been introduced in the specifications of other telegraph administrations, it becomes the task of every telegraph wire manufacturer to test his wire as to its conductivity.

A great number of tests made with the different materials considered suitable for telegraph and telephone wires produced on an average the results collected in Table I., which will be of general interest.

These results give rise to the following reflections :—

Copper.—The use of copper for conducting wires was discontinued as soon as the application of telegraphs began to assume large proportions. However much copper may be recommended on account of its high conductivity, it appears to be the least suitable material for telegraph lines of any considerable importance, in consequence of its low-breaking strain and elasticity, as well as its high value, which render the investment so very great, besides exposing the wires to the danger of being stolen. The fact of copper being allotted a place in these tests is that it may serve as a basis for drawing a comparison between the qualities discovered in other materials.

Puddled Iron (generally called best best).—Iron has undoubtedly found by far the most extensive application for conducting purposes, and of the different kinds of iron, more especially puddled iron, which, with cheapness of cost, combines a sufficiency of conducting power. Formerly, it was usual to protect the wire from corrosion by means of dipping it in boiled linseed oil, until a means was found in the galvanising process which, though more expensive, proved far more efficient in affording the iron lasting protection from destructive atmospherical agencies.

The tests made with this material proved that in order to have a like conductivity resistance to that of copper wire the iron wire must have a sectional area $8\frac{3}{4}$ times as large as the copper wire. The specific gravity of iron in proportion to that of copper is as 6:7, therefore a wire of puddled iron will weigh $8\frac{3}{4} \times \frac{6}{7} = 7\frac{1}{2}$ times as much as a copper wire of equal conductivity. The strain brought to bear on the stays would be $7\frac{1}{2}$ times as much as in the case of copper wire of equal conductivity in consequence, but by virtue of its higher breaking strain, which is to that of copper as $40:28 = 10:7$, it is possible to span proportionately longer distances, *i.e.*, to place the stays farther apart.

With a view to a comparison of cost, the nominal value of a galvanised puddled iron wire of four millimetres may be taken as m.25 per 100 kilogrammes. The conductivity resistance of this wire is, according to measurements, 12 Siemens units per kilometre, *i.e.*, equal to the resistances of a copper wire of 1·4mm. A kilometre of galvanised puddled iron wire 4mm. thick weighs in round figures 100 kilos., costing m. 25; and as a kilometre of copper wire 1·4mm. weighs in round figures 14 kilos., and costs on an average m. 190 per 100 kilos. = m. 26·40 per kilometre, the difference in prices would not be great with equal conductivity.

Swedish Charcoal Iron Wire.—Of the different iron and steel wires Swedish charcoal iron wire possesses the highest conductivity, viz., $16\frac{1}{2}$ per cent. of that of copper wire.

With equal conductivity, a wire of that material may, therefore, be taken lighter in proportion, as $12 : 16\frac{1}{2}$ (or $8 : 11$) than a puddled iron wire. In such cases, where a puddled iron wire of 4mm. would be required, weighing in round figures 100 kilos. per kilometre, a Swedish charcoal iron wire of 3·4mm., weighing but 70 kilos. per kilometre, would be quite sufficient so far as conductivity was concerned.

By means of this material it is possible to considerably lessen the strain on the stays (by more than $\frac{1}{4}$th), and to construct the whole line lighter.

If, however, the Swedish wire is used in the same size as the puddled wire generally used, a greater rapidity of transmission is the result, as $11 : 8$.

The virtue of spanning, however, is less by 10 per cent (at least with the soft quality used for conducting wire) than that of puddled iron wire (the breaking strain amounting to only 36 instead of 40 kilos. per square millimetres) which necessitates a proportionate reduction of the distance between the poles.

It is true the Swedish material is considerably higher in value. A wire 4 mm. thick made of this material has a nominal value of m.45 per 100 kilos., being m.20, or 80 per cent. more than that of puddled iron wire. Taking into consideration the higher conductivity a wire of 3·4mm., costing about m.47 per 100 kilos. = m 32·90 per kilometre would but do the same service as a puddled iron wire of 4 mm. costing only m. 25 per kilometre. Swedish iron wire would, therefore, be 31·6 per cent. dearer than puddled iron wire.

It is to be concluded from this comparison that the Swedish material can only be chosen in such cases where the rapidity of transmission attainable, or the possible lighter construction of the line, will justify the greater outlay.

Swedish Bessemer Steel Wire.—With about the same conductivity as Swedish iron wire (16 per cent. of that of copper wire) the Swedish steel wire, in the temper solely suitable for conducting purposes, possesses the same breaking strain as puddled iron wire (40 kilos. per square millimetre of sectional area).

With regard to elasticity, the Sweedish steel and iron wire are not different from soft puddled iron wire, the changes of temperature having the same elongating effect on the one as on the other.

There is no difference in price between Swedish steel and iron wire. The only advantage of Swedish steel wire is, therefore, its higher breaking strain, whereas its conductivity is slightly less than that of iron wire.

German Charcoal Iron Wire.—This wire is about a medium between puddled iron wire and Swedish steel wire with regard to conductivity. It is only suitable for conducting purposes if quite soft, when it has the same breaking strain as puddled iron wire, viz., 40 kilos per □ mm.

As concerns elasticity it stands on a par with other soft iron and steel qualities.

For a comparison of prices the nominal value of German charcoal iron wire 4 mm. thick may be regarded as m.30 per 100 kilos, that is to say 20 per cent. higher than puddled iron wire of equal sizes.

Taking into account the superior conductivity of this quality, a German charcoal iron wire 3·7 mm. thick, will not afford a higher resistance than a puddled iron wire of 4 mm., at the same time weighing in round figures only 84 kilos. per kilometre and costing (at m.31·50 per 100 kilos.) m.26·46.

The cost would not exceed that of puddled iron wire of equal conductivity by more than 6 per cent.

The greater outlay would, therefore, as is the case with the Swedish material, only be justifiable by the necessity of a greater rapidity of transmission, or of a lighter construction at an equal speed of transmission.

German Flusseisen.—The German "Flusseisen" wire, the conductivity of which is rather more than 10 per cent. greater than that of puddled iron wire, is very suitable for telegraph purposes, and has also been much applied to telephone lines.

Even the softer kind of Flusseisen wire has a breaking strain five per cent. higher than that of soft iron wire, whereas the harder kind with a breaking strain of 60 to 65 kilos. per □ mm., is also very suitable for conducting purposes on account of the particular tenacity and ductility of this material.

A galvanised Flusseisen wire of 4 mm. has a nominal value of m.35 per 100 kilos., that is to say, 40 per cent. more than puddled iron wire.

With a like weight, however, a rapidity of transmission 10

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TABLE I.—*Results of Tests made with Telegraph and Telephone Wires.*

Name of Materials.	Breaking Strain per sq. mm. in kilos.	Breaking Strain of Wire of 4 mm. kilos.	2·5 mm. kilos.	2 mm. kilos.	1·25 mm. kilos.	Conductivity Resistance of 1 kilometre of Wire at + 15 deg. Cent. 4 mm. S.E.	2·5 mm. S.E.	2 mm. S.E.	1·25 mm. S.E.	Proportion of Conductivity per cent. as compared with that of pure Copper.
Copper wire	28	352	137	88	34	1·5	3·7	5·8	14·8	100
Phosphor bronze wire	55	690	270	173	67	6·5	16·8	26·2	67·4	22
Galvanised Swedish charcoal iron wire, soft	36	452	176	113	44	8·7	22·4	34·9	90	16·5
Galvanised Swedish charcoal iron wire, hard	50	628	245	157	61					
Galvanised Swedish Bessemer steel wire, soft	40	502	196	126	49	9·0	23·1	36	92·6	16
Galvanised Swedish Bessemer steel wire, hard	60	754	294	188	73					
Galvanised charcoal German iron wire, soft	40	502	196	126	49	10·3	26·4	41·1	106	14
Galvanised charcoal German iron wire, hard	55	690	270	173	67					
Galvanised Siemens-Martin-Flusseisen wire, soft	42	528	206	132	51	10·8	27·7	43·3	111·5	13·3
Galvanised Siemens-Martin-Flusseisen wire, hard	65	816	319	204	79					
Galvanised puddled iron wire, soft..	40	502	196	126	49	12	30·8	48	123·5	12
Galvanised patent cast steel wire, soft	95	1,193	466	298	116	13·7	35·2	54·9	141·2	10·5
Galvanised patent cast steel wire, hard	140	1,758	686	440	171	15·2	38·9	60·6	156	9·5

TABLE II.—*Comparative Table of Telephone Wires made of different Materials having the uniform conductivity resistance of* 68 *S.U. per kilometer at* + 15 *deg. Cent.*

Name of Materials.	Size of Wire. Accurate mm.	In round figures mm.	Breaking strain. Per sq. mm. of section.	Per Wire.	Proportion.	Weight per 1,000 m. in kilos.	Maximum span with a pitch of 0·75 m. per 100 m. metres.	Minimum pitch for a span of 100 m. metres.	Proportion of span.	Price per 100 kilos marks.	1,000 meters marks.	Proportion.
Phosphor bronze	1·25	1·25	55	67	100	10·94	92	0·82	100	320	35·00	100
Copper	0·58	0·6	28	8	12	2·52	48	1·58	52	240	6·05	17 3-10
Galvanised puddled iron wire ...	1·68	1·7	40	91	136	17·34	79	0·95	86	39	6·76	19⅓
Galvanised Flusseisen wire	1·60	1·6	65	131	196	15·36	128	0·59	139	49	7·53	21½
Galvanised Patent cast steel wire, soft	1·80	1·8	95	242	361	19·44	187	0·40	203	64	12·44	35½
Galvanised Patent cast steel wire, hard	1·89	1·9	140	397	593	21·66	275	0·27	300	69	14·94	42 7-10

N.B.—In calculating spans and pitch we have used the formula :—

$$(1)\ \text{Span}\ a = \sqrt{\frac{8 \cdot f \cdot s}{g}} \quad \text{where } g = \text{weight in kilos per metre}$$

$$(2)\ \text{Pitch}\ f = \frac{g \cdot a^2}{8\,s} \quad \text{,,}\ s = \text{span} = \tfrac{1}{4} \text{ of breaking weight.}$$

per cent. greater is obtained, and since the breaking strain is greater by more than one half, whereby the supports may be placed so much farther apart, the higher price is justified under certain circumstances, and may even be quite compensated for by the cheapness of construction of the whole line.

Patent Cast Steel Wire.—For telegraph lines the cast steel wire can only be considered where long spans are absolutely required and unavoidable. Its small conductivity, which is only 9½ to 10½ per cent. of that of copper, counterbalances the advantages derived from its higher breaking strain and high limit of elasticity.

For other purposes its breaking strain, which is for the softer kind 95, and for the harder 140 kilos. per □ mm., will permit of a sectional area only about ⅓ of that of iron wire to obtain an equal breaking strain, and by a reduction in weight so considerable the difference in cost is more than balanced. A puddled iron wire of 4 mm. has not a higher breaking strain than a cast steel wire of the harder kind of 2·2 mm. whereas the former weighs per kilometre 100 kilogrammes, and costs m. 25, the latter only weighs 30 kilos., and costs (at m. 67 per 100 kilos.) only m. 20·10. The former has a conductivity resistance of 12 S.U. and the latter 73·32 S.U.

To obtain an equal resistance of 12 S.U., the patent cast steel wire would require to have a diameter of 4·5 mm., weighing in round figures 125 kilos. per kilometre, and costing (at m. 63 per 100 kilos.) m. 78·75, *i.e.*, more than three times the price of puddled iron wire of like conductivity.

Phosphor Bronze.—In consequence of the great modern development of telephony, and of the special requirements imposed on wire for telephonic conduits, phosphor bronze has been put forward in different quarters as being the most excellent material for telephonic conduits. As it has been attempted on several occasions to apply this material to telegraphy, it may also be compared with others.

Trials made with phosphor bronze wires manufactured by different makers went to prove from the first that breaking strain and conductivity are also with this material in inverse proportion—that is to say, the conductivity resistance increases with the breaking strain.

The most favourable result obtained as to conductivity has been inserted in Table I., and shows a conductivity of 22 per cent. of that of copper, and a breaking strain of 55 kilos. per □ mm.

The highest breaking strain observed was 110 kilos. per □ mm., but on measuring the conductivity of the samples giving this result only 8 per cent. of the conductivity of copper was found, besides which the wire was too brittle by far for the purpose intended.

In order to compare the cost, it may be assumed that this wire was to be had at m. 320 per 100 kilos., or about 50 per cent. more than the price of copper wire. Phosphor bronze wire having about double the breaking strain of copper wire (55 kilos. as against 28 kilos. per □ mm.), it would cost about 25 per cent. less than copper wire, the length and breaking strain being identical. The conductivity of phosphor bronze wire with the same breaking strain and half the section and weight would, however, be only 11 per cent. of that of copper wire.

In comparison with galvanised puddled iron wire, as phosphor bronze wire of 3 mm. would give about the same conductivity resistance as a galvanised puddled iron wire of 4 mm., it would weigh 63 kilos. as against 100 kilos., but the price would be m. 201·60 as against m. 25 per kilometre, or about eight times as much. Besides this disadvantage phosphor bronze wire is, like copper wire, exposed to the danger of being stolen.

If in the case of phosphor bronze wire a point be made of its faculty of withstanding the corrosive effects of atmospherical exposure, and the advantages derived therefrom, galvanised wire does not range second to it in this respect. Phosphor bronze wire affords, therefore, no advantage beyond the higher breaking strain (in proportion as 55 to 40), as compared with common galvanised iron wire.

A comparison with the other iron and steel wires is, after the above, useless.

A comparison with galvanised cast steel wire is treated in its proper place under the head of Telephone wires.

2.—*Telephone Conducting Wires.*

As aërial telephone lines must, in most instances, be led over roofs of houses, across public streets and squares, &c., the requirements imposed on telephonic wires are very exacting; the

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wire must allow of its being spanned with absolute security between the supports even for the widest distances when traversing public ways, as the breaking of a wire may be attended with the gravest consequences. This method of leading the wires over the roofs necessitates the lightest possible construction of the whole line, and, consequently, the employment of as small gauges of wire as possible, in order to lessen the strain brought to bear on the supports that the latter may be employed of a light description. In order to meet these requirements, which in the case of aërial lines are predominant, the conductivity of the wire, which diminishes with the size of the wire, must be regarded as of secondary importance.

In order to get a clear understanding as to what material is most suitable for aërial telephone lines, and how far one material deserves preference over another, it is necessary first of all to establish what conductivity resistance is necessary, to show that a material answering to all other requirements is also suitable as concerns conductivity.

Practical results of a reliable nature do not appear to have been obtained yet, but it is contended by many that a phosphor bronze wire of 0·8 mm. even, has sufficient conducting power, and that if it be true that no smaller phosphor bronze wire than 1·25 mm. be used, this is done because a wire any smaller would present too great difficulties in handling and fixing on the roofs.

Now, as the results of tests stated in Table I. show that a phosphor bronze wire of 0·8 mm. has a resistance of 164 S.U. per kilometre, it is to be assumed that this resistance is admissible.

As, however, no smaller phosphor bronze wires than 1·25 mm. are used, and these, as shown by the tests before mentioned, have a resistance of 67·4, or in round figures 68 S.U. per kilometre, such sizes of wire have been chosen for the comparison of materials in Table II. that all wires have the same conductivity in round figures of 68 S.U. per kilometre.

Table II. suggests the following reflections:—

Copper.—A comparison with copper shows that a phosphor bronze wire of same resistance has about a fourfold greater weight and costs six times as much as copper wire, while admitting of double the distance between the posts.

Both copper and phosphor bronze wires are equally liable to be stolen in consequence of their high value.

Galvanised Puddled Iron Wire.—To obtain the same resistance as a phosphor bronze wire 1·25 mm. thick, a puddled iron wire of 1·68 mm., or in round figures 1·7 mm., must be employed, the breaking strain of which is inferior in proportion as 40:55, whereas its weight presents no objection. The cost of the galvanised puddled iron wire is only 19½ per cent. of the price of phosphor bronze wire of equal resistance.

Galvanised Flusseisen Wire.—Flusseisen wire has already been much used for telephone purposes. Its particular tenacity and pliancy render even the hard kind, having a breaking strain of 65 kilos. per □ mm., suitable for this purpose. Its conductivity is such that a wire of 1·6 mm. has the same as a phosphor bronze wire of 1·25 mm., or a puddled iron wire of 1·7 mm. The supports may be placed farther apart than with phosphor bronze wire, in proportion as 139:100, or ⅓ farther. The unit of length of Fluesseisen wire of equal conductivity weighs somewhat less than one-half more than phosphor bronze wire, and will bear more on the supports in the same proportion. In comparison with puddled iron wire Flusseisen wire admits of spans ½ longer, and the strain borne by the supports is about 10 per cent. less.

The same length of Flusseisen wire, always of equal conductivity, costs only about ⅕ of the price of phosphor bronze wire, or about 10 per cent. more than puddled iron wire.

Galvanised Patent Cast Steel Wire.—There is no material affords greater security than patent cast steel wire against the danger of broken wires, and the often fatal consequences to any persons happening to be passing through the streets at such times. In consequence of its high limit of elasticity it suffers less through the strain caused by sudden changes of temperature, and its high breaking strain permits of spans over very considerable distances. Its breaking strain is about six times greater than that of copper, three and a half times greater than of puddled iron wire, and all other soft iron and steel wires, three times greater than that of phosphor bronze wire, and two one-fifth times greater than that of Flusseisen wire.

With like conductivity, patent cast steel wire will strain the supports about twice as much as phosphor bronze wire, ¼ more than puddled iron wire, and one-third more than Flusseisen wire. Thus it will be seen the choice of material depends much on whether the greater distances between the supports or the lighter construction of the line is of paramount importance.

With regard to prices, the table shows that patent cast steel wire is fully twice as dear as puddled iron wire, and exactly twice as dear as Flusseisen wire, whereas it only costs about two-fifths of the price of phosphor bronze wire.

If the assertion referred to at the introduction of these remarks, that as concerns conductivity a phosphor bronze wire of 0·8 mm. is sufficient, then a galvanised patent cast steel wire of 1·25 mm. with a conductivity resistances of 156 S.U. will do just as well. A comparison of a phosphor bronze wire of 1·25 mm. with a patent cast steel wire of the same size gives the following result:—

	Phosphor Bronze Wire.		Patent Cast Steel Wire.
Conductivity................	68 S.U.		156 S.U.
Breaking Strain	67 kilos		171 kilos
Weight per 1,000 metres	11 kilos		9½ kilos
Price per 100 kilos	M. 320.		M. 72·
Price per 1,000 kilos	M. 35·20		M. 6·84
Or in proportion as................	100	to	19½

In this case the phosphor bronze wire has less than ½ the resistances of patent cast steel wire, but the resistance of the latter is yet sufficient, and the wire could be spanned over a distance three times as great, being 14 per cent. lighter in weight, the strain brought to bear on the supports would be proportionately less, and the cost 80½ per cent. less (that is to say, phosphor bronze would cost about 6 to 7 times more than cast steel wire).

Galvanised patent cast steel wire is at the present time mostly used in the sizes 2·0, 2·2, and 2·5mm.; but if the minimum limit of conductivity can be placed as low as above stated, cast steel wires of 1·2, 1·4, and 1·6mm. are quite suitable, to which the following figures apply:—

	Patent Cast Steel Wire (Galvanised.)				Phosphor Bronze Wire.
	1·2	1·4	1·6		1·25mm.
Resistances S.U................	168	124	95	......	68
Breaking Strain Kilos.	158	215	281	......	67
Weight per 1,000m. kilos.......	9	12	15½	......	11
Price per 100 kilos. m.	72·	71·	70·	......	320·
„ „ 1,000 metres m.......	6·50	8·50	11·	......	35·20

Compared with a patent cast steel wire of 1·6mm., a phosphor bronze wire of 1·25mm. would have a resistance about ⅓ lower, and weighs 29 per cent. less, but would require 3 times as many supports (though these might be of a lighter description), and cost three times as much.

As a result of the above reflections, it seems to carry conviction that galvanised patent cast steel wire is in all respects the most suitable material for telephonic lines.

A process used in the United States of America for increasing the conductivity of steel and iron wires by means of a galvanic deposition of copper merits some attention. This coating of copper is mostly 0·1mm. in thickness, or increases the size of the wire by 0·2mm. If, for instance, it were intended to provide a cast steel wire 1·6mm. thick, of the harder temper, with such a copper covering (which should not present any difficulty) a coppered cast steel wire of 1·8mm. would be obtained. The sectional area of this wire being 2·545 □ mm., the steel wire would absorb 2·011 □ mm. of said area, and 0·534 □ mm. would be taken up by the copper coating. Copper having a superior conductivity to the harder temper of steel—in proportion as 100:9½—the copper section of 0·534 □ mm. would represent a steel section of 5·621 □ mm., which, together with the section of the original steel wire, viz,, 2·011 □ mm., gives a total section of 8·166 □ mm., corresponding with a wire of fully 3·2mm. diameter.

The coppered patent steel wire of 1·8mm. would thus have the same resistance as a galvanised steel wire of 3·2mm., and the same breaking strain as a steel wire of 1·6mm. It would weigh about 20 kilos. per kilometre, and the strain on the supports would be greater in proportion as 20 to 15, whereas the faculty of spanning would be reduced in like proportion, viz., as 15:20; the conductivity of the wire would, however, be quadrupled (24 instead of 95 S.U. per kilometre). As compared with a phosphor bronze wire of 1·8mm., such a coppered steel wire of 1·8mm. allows of being spanned over double the distance, weighs fully 10 per cent. less, has a conductivity resistance about ¼ less, and costs hardly one-third part.

In conclusion, it may be mentioned that aërial lines of wire fixed to insulators can only be regarded as temporary, at least for large cities, as the number of wires in many places has already assumed such proportions that a still further extension seems hardly possible. The necessity of placing the wires underground in large cities is being more and more felt, and electricians will have to apply themselves seriously to the study of suitable constructions of cables underground to do away with the inconvenience experienced from aërial lines.

NOTE.—Money is given in German marks, equalling one English shilling.

—*Translated from Electrotechnische-Zeitschrift.*

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THE ELECTRICIAN.

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All communications to be addressed to 396, Strand, London, W.C.

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THE CRYSTAL PALACE EXHIBITION.

With the formal visit of the Speaker and members of Parliament last Saturday the Crystal Palace as an exhibition of electrical appliances may be said to have terminated. For another week the show was kept open for Whitsuntide holiday-makers; but the process of packing up, which had already begun, will by the close of this week be well nigh completed. It is too soon to offer an opinion as to the scientific results of this remarkable gathering; but considered merely as an exhibition we believe we are correct in saying that it has been in every respect a great success. Exact statistics are not before us of the number of visitors in excess of the average ordinary attendance at the Palace; but any one who has paid chance visits to it during the past three or four months could not fail to notice the unaccustomed crowding and the unwonted interest taken in what was going on. The cost of management, no doubt, has been largely augmented during this period, but we have reason to believe that, on the whole, the proprietors will not experience any financial disappointment as a consequence of their bold venture.

We call it a bold venture, for one might have supposed that the telegraph and all that pertains to it had long ago ceased to be a wonder, and that, even with an attractive show of electric lighting thrown in, the exhibition would scarcely be considered popular. This, however, has not proved to be the case, the visitors in the day time being quite as numerous as those arriving specially for the night time display. It is evident, therefore, that the inner life, if we may so call it, of signalling messages by electricity is still as great a mystery to the public as ever. Following the groups from stall to stall, the wonderment, or, as some would say, the ignorance, displayed by people otherwise well informed was itself a thing to marvel at. Fortunately for the organisers of exhibitions of every kind, the average public trouble themselves little about why and how their necessities are ministered to, but are very willing to be shown and to take an intelligent interest in the proceeding, if only you can arouse their curiosity. This the electrical exhibitions, both at Paris and here at Sydenham, were eminently calculated to do. The multitude of beautifully constructed apparatus, as manifold in their design as puzzling in their application, evidently took everybody by surprise, and wherever an attendant was placed to answer inquiries his task was by no means a light one. The fewness of these attendants has in our opinion been a drawback to such exhibitions. Wherever there was an attendant there the crowds would congregate, and the people who disdained his assistance were as rare and as isolated as are those very superior parties who would do Notre Dame without a commissionaire, or climb the Matterhorn without a guide.

For similar reasons the lectures were very well attended, although they were not uniformly framed on popular lines. This experiment was quite a novel one, and when first mooted was chiefly suggestive of the dreary ineptitudes of the Polytechnic. But the result was quite different; and on the subject of electric lighting especially the interest awakened was very general. We would fain hope that nothing that was said on those occasions contributed in any way to the mania which has since set in on the Stock Exchange. Doubtless the lecturers believed in their own predictions; but the predictions of scientific men are better suited for the atmosphere of science, where speculations of that kind are not interpreted as encouragement to speculation of a quite other kind, than for the ears of an unlearned and impressionable multitude, who are apt to take things literally, especially where there is a seeming prospect of making money by them.

The display of electric lighting was, we need hardly say, superior to anything of the kind ever witnessed before. Both for the variety of the lights, the pains bestowed upon their decorative capabilities, and the advantageous positions they occupied, the English exhibition was far ahead of its predecessor on the other side of the channel. The best that both arc lights and incandescent lights could do in the circumstances, or indeed in almost any circumstances, were here fully developed; and we should imagine that the exhibitors themselves had as much satisfaction in the opportunities afforded them of displaying their lamps to advantage as the public had in seeing them. The people who hastily concluded that the hideous contrivances which first made us acquainted with electric lighting out of doors, and which are even now not quite banished from the centre of the metropolis, were the inevitable adjuncts of this new favourite, must have been agreeably surprised at what they saw at the Crystal Palace. It turns out, indeed, that of all the methods yet devised for illuminating our houses, this, the latest, lends itself most easily to the demands of good taste. On every hand it was declared that the lamps were beautifully mounted and tastefully arranged. In several instances they were superb, and the utterly-all-but community were constrained to admit that there is still some hope for modernism when it is capable of such charming inventiveness as this. Moreover, the colour of the lights was in most instances irreproachable, and objections on this score,

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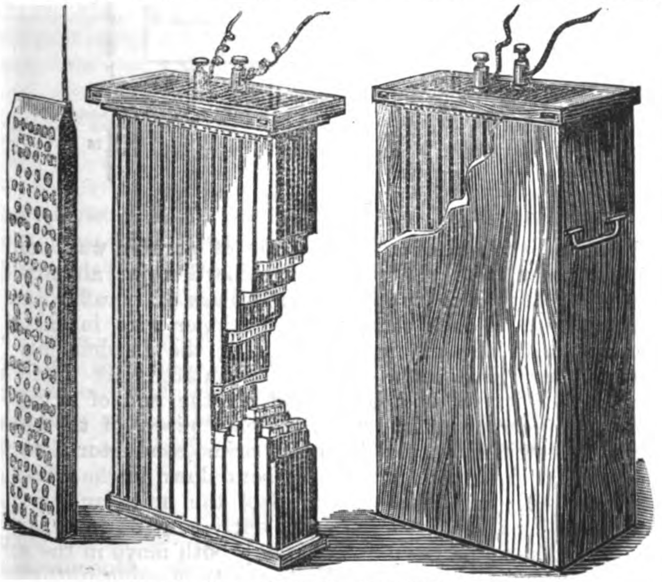
which were frequent and loud twelve months ago, are now no longer heard. The utility of the arc light for outdoor lighting is beyond all question; the attractiveness of the incandescent light for indoors is now rendered almost equally sure. Our notices of the various exhibits have not kept pace with the exhibition itself, but with the enlarged space now at our command we hope to give fuller descriptions of many interesting objects which as yet we have scarcely been able to mention.

Since writing the above we learn that efforts are being made to extend the exhibibion over another three months. We sincerely hope that the appeal which the managers are now making to the exhibitors to allow their property to remain on view during the period named will meet with a favourable response.

ACCUMULATORS FOR INDUSTRIAL PURPOSES.

The following account of some improved accumulators which have been constructed with corrugated plates was communicated by M. N. de Kabath to a recent number of *L'Electricien*:—"The battery is made up of a number of vertical plates, arranged as shown below. Each plate is composed of a series of strips of lead, 1-10th of a millimetre thick, and of a convenient length. These small lead plates are alternately corrugated and flat, and are placed one against the other until they finally form one large plate, 8 or 9 centimetres wide, containing from 80 to 100 of the small plates. They are kept in position and firmly held by a perforated lead plate, which entirely surrounds them at the same time that it permits free circulation of the liquid (see Figure). The vertical type of battery



Kabath's Accumulators for Industrial Purposes.

is composed of twelve such plates, connected alternately to the two terminals. The two end plates are plain sheets of lead, thus making the total number of plates fourteen. They are solidly fixed to the cover at the top, and at the bottom are held in position by placing them in an insulating glue formed of black resin and paraffin. In the cell for laboratory purposes the plates are smaller, and only six in number. They are also placed in a glass jar, the better to study the action consequent on charging or discharging. In the cell constructed for industrial purposes, the outer case is of wood with leaden covering and furnished with handles, the better to move it about. The plates are about 40 centimetres high, 85 millimetres wide, and 1 centimetre thick. The battery weighs 30 kilogrammes with box, and without liquid, and abcut 35 kilogrammes with water combined with 1-10 acid, ready for work."

CORRESPONDENCE.

WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Dr. Shettle's letter to you of 25th of April last has been unanswered for the following reason:—In proof that electricity is matter, I had drawn his attention to the contracting action of electricity around an insulated metallic ball at the time an insulated conductor is brought near to it. Dr. Shettle has attributed this action to friction, but this is a palpable absurdity in the light of the facts concerning the nature of electricity known at the time he wrote, but as I have been making experiments, by which I have discovered more information about the nature of electricity, I delayed replying to Dr. Shettle's letter until my own arrangements for publishing my new experiments were completed.

These new experiments, and the discovery made through them, depend on the trustworthiness of the insulated gas-flame as a test of the direction in which currents of electricity move. Your readers will, no doubt, remember the challenge of

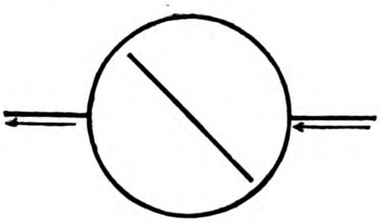


FIG. 1.

the accuracy of this test which Professor Silvanus P. Thompson made, as published in *The Electrician*, Vol. VIII., page 141, in these words:—"As to your experiments of the year 1839, there is an unproven assumption underlying the whole of them, namely, that a test flame moves in the direction in which electricity moves, which may or may not be true, and which is no test at all until you have by some other and independent process proved that the electricity is really moving in the direction in which you assume it does." This challenge compels me, in the first place, to adduce proof regarding the trustworthiness of the gas flame test.

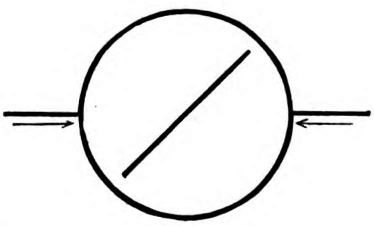


FIG. 2.

Every electrician who has had any experience in the employment of dynamo machines to keep on operation a series of arc lights has been forced by facts to believe that a current of electricity goes out by the one set of wires, technically called the "leads," and that the current comes back to the machine by the return wire. Further, on inspecting the arc-lights in action every electrician knows which way the electricity is moving, because the one carbon becomes concave at its point and the other becomes convex. If these carbons be placed in a horizontal position and in a vacuum the particles of carbon continually rush from the concave point to the convex one, so that the convex point diminishes in size, while the convex one grows in bulk, and if the light be magnified and thrown on to a screen the human eye sees this rushing of the particles of carbon from the concave to the convex point. This is ocular proof that the current of electricity is moving in the direction indicated by the particles of carbon. Again, when a galvanometer is employed to indicate the direction in which a current of electricity is moving it gives us the information in the following manner: When the current is going through the wire from the

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right-hand to the left, then the top of the index of the galvanometer moves from the perpendicular position towards the left-hand, as shown in Fig. 1.

When the current is going from the left to the right, then the galvanometer index moves so that the top of it goes from the perpendicular towards the right-hand, as shown in Fig. 2.

These two instruments, the arc light and the galvanometer, serve the purpose of testing the accuracy of the gas flame test in the following manner:—Fig. 3 represents a glass tube with the full-sized gas flame placed between two wires for testing the direction of a current of electricity

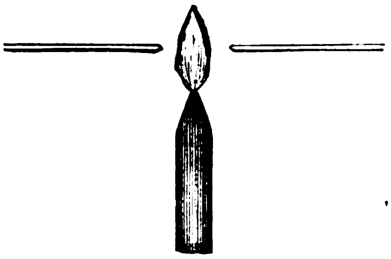

Fig. 3.

when all the three instruments are applied in conjunction. When the points of the arc light and the galvanometer indicate that the current of electricity is going from the right-hand to the left the flame is driven from the right hand to the left, as indicated by Fig. 4.

When the points of the carbon and the galvanometer indicate that the current of electricity is going from the left hand to the right, then the flame is driven from the left hand to the right, as indicated by Fig. 5.

This similarity of action of the insulated gas-flame with the action of the carbons and the galvanometer is a sufficient

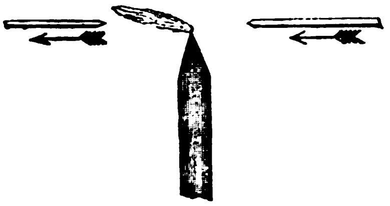

Fig. 4.

proof of the trustworthiness of the gas-flame as an indicator of the direction in which currents of electricity move.

The new experiments about to be described were begun with the intention of discovering the cause of the phenomenon of the Leyden jar. As Franklin had by his invention of the Leyden jar with movable coatings determined that the phenomenon of the Leyden jar resided in the glass of which it is made, I wished to test this in another way; so with a large Leyden jar, measuring seven inches in diameter, and thirteen inches in height, I ascertained how many charges of electricity of a unit jar it took to charge the

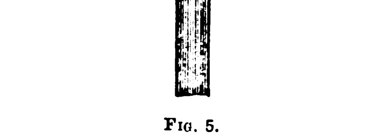

Fig. 5.

large Leyden jar. I then filled this Leyden jar with melted paraffin wax up to the mouth of it, so that all air was excluded from the interior of the jar. After it had been allowed to stand for two days, so that the paraffin wax was cold and hard, I then tested the jar's capacity for holding electricity by charging it by means of the same unit jar, and found that there was no difference in the number of charges required to fill the paraffin-loaded Leyden jar. This experiment demonstrated that the air inside a Leyden jar does not affect the amount of charge the jar is capable of holding. I now emptied the paraffin wax out of the jar, and placed inside of it fourteen pounds of small scrap iron, which amount just reached to the top of the tinfoil inside the jar. I now tested the jar with the unit jar charges, and found that the fourteen pounds of scrap iron made no difference in the number of unit jar charges required to charge the Leyden jar; hence there is proof that the inside lining of tinfoil must have very little to do with the amount of charge of electricity that a Leyden jar can take. The phenomenon of the Leyden jar, therefore, depends upon the glass of which the jar is made. There is another peculiarity in Leyden jars which requires to be noted here, as it has an important bearing on the explanation of the succeeding experiments, namely, the well-known fact that a Leyden jar will not take a charge of electricity if the jar be thoroughly insulated. I tested this by coating the foresaid Leyden jar all over the outside of it with a thick coating of paraffin wax, and then placed the jar on the top of pillars of paraffin wax. I then found that the jar could not be charged when in this state, but on passing a sharp-pointed wire through the coating of paraffin till it reached the tinfoil coating of the jar, then the jar was able to take a charge of electricity. The reason of the foregoing is, that electricity will not move in any direction unless facility be given to it to form a current. The sharp wire passed through the paraffin to the tinfoil coating, and the other end of the wire put to earth, gave the facility for a current of electricity to pass through the jar, and then it took a charge.

Fig. 6 is a representation of the apparatus by which the new experiments were made. A is a brass ball attached to the prime conductor of a frictional machine, by which a supply of electricity was obtained. B is a glass tube with insulated gas flame on the top of it. C is a unit jar for measuring the quantity of electricity passing. This jar is

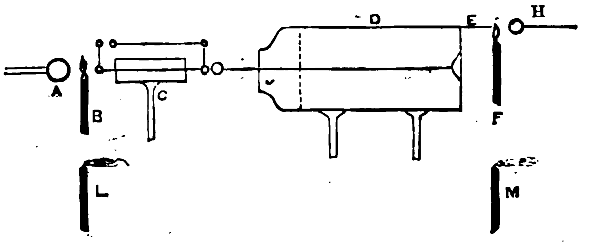

Fig. 6.

placed on the top of a stand made of paraffin wax, and is thereby insulated. D is the large Leyden jar already described. It is also supported on pillars of paraffin wax to insulate it. E is a sharp-pointed copper wire in metallic contact with the external coating of the Leyden jar. F is another glass tube with an insulated gas flame on the top of it. H is a brass ball, on the end of a copper wire, in communication with the gas pipes of the house. When electricity passes from the prime conductor A to the unit jar, the flame B is violently bent down in the direction shown by L; and when a charge of the unit jar C passes into the jar D, the flame F is violently bent down as shown by M. The flame B and the flame F both move in the same direction, indicating that, while electricity is going in through the flame B, electricity is coming out of the jar D through the glass and the flame F. At the first discharge of the unit jar C into the jar D the flame F is as much bent down as the flame B, but on each succeeding charge of the unit jar going into the jar D the flame F becomes less and less affected till at last the flame F stands upright; the jar D is then fully charged. The moment electricity ceases to go into the Leyden jar D, that instant electricity ceases to come out through the glass and go by the wire E through the flame F. In the published document which I sent to Faraday, Arago, and others, in 1839, I stated that, from the experiments then made, I had reason to believe that *static induction* had no existence in fact; that the phenomena of electricity were all produced by one electricity; and that it was not like the one electricity of Franklin, who imagined that electricity and matter did each possess a repellent power within themselves, whereas I maintain that electricity has no repellent power.

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All the phenomena supposed to be from repulsion arise from attraction. But to return to the facts of experiment. The phenomenon of the Leyden jar does not arise from *static induction*, because *static induction* requires the glass to be impervious to electricity, that is, that one kind of electricity accumulates on the inside of the glass of the Leyden jar, and that the other kind of electricity is induced to accumulate on the outside of the jar, and that neither of the electricities can pass through the glass of the jar. Now, it is manifest that the electricity does pass through the glass of the jar, because the two gas flames B and F both bend in one direction. B bends towards the right hand, showing that electricity is going into the unit jar. F bends towards the right hand, showing that electricity is coming from the outer coating of the jar. Where is it coming from? It must be coming through the glass. This is proved by the following experiment, and it puts an end to the myth called *static induction*:—

The same arrangement of apparatus as before is continued, except that a plug of paraffin wax is placed in the mouth of the jar D, and there is inserted into it a piece of No. 16 copper wire (see Fig. 7) through the paraffin plug, so that the wire is insulated. Six inches of the wire extend inside the jar, and it is in contact with nothing but the air inside the jar; the outer end of the wire is sharpened to a fine point. With this arrangement of the jar D a different result takes place. At first the flame F is affected in the same way as in the former experiment, and, as each succeeding charge of the unit jar goes into the jar D, the flame F becomes less and less affected, until the flame F stands nearly erect; but when the number of charges of the unit jar have passed into the jar D, which formerly was sufficient to charge the jar D, it is found that the flame is still

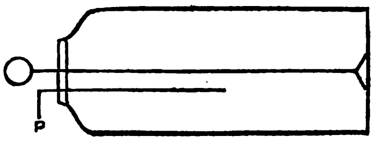

FIG. 7.

affected by every succeeding charge of the unit jar which goes into the jar D, and although the experiment be carried on for hours, yet it is found that an escape of electricity passes through the flame F every time a charge of the unit jar passes into the jar D. As I have said, the experiment may be carried on for hours, and yet electricity will continue to escape through the flame F. Hence it is manifest that it is a part of the electricity which is going into the jar D which comes out through the glass and passes through the flame F. From the time the charging of D is commenced a small stream of electricity rushes out by the pointed wire P. There is thus a current of electricity formed through the interior of the jar. As long as provision is made for this current of electricity to go on in the interior of the jar a part of the electricity comes out through the glass and goes through the flame F. When a piece of paraffin wax, made for covering the wire P, is placed on the point of it, this stops the electricity from coming out by P, and this stops the internal current in jar D; then no electricity will go into the jar D from the unit jar, and no electricity comes out through the glass to the flame F. It was proved that electricity will not go into an insulated Leyden jar to charge it, because there was no current of electricity through it, no outlet through the glass while the jar was insulated. So with the charged jar D; because the electricity inside of it is of the same potential as the potential of the current by which it is being charged. Electricity stops going into the jar, and this stops the current of electricity within the jar. We can understand that electricity will not go into an insulated Leyden jar, because the insulation prevents the glass permitting a part of the electricity to pass through it; and, therefore, no current of electricity can be formed through the jar, and because there is no path for a current, the electricity will not enter the jar. And so with the charged Leyden jar, when the potential of the electricity within the jar has risen to the same potential as the current of electricity that was going into the jar, it is obvious that the jar can hold no more electricity, and hence the current going into the jar stops, and with the stoppage of the current going into the jar, the current coming out through the glass of the jar also stops. But, seeing that the potential of the electricity inside the jar is so much greater than that of the outer coating of tinfoil of the jar, and that while the jar was being charged electricity did come out through the glass and outer coating of the jar, what prevents the electricity from coming out through the glass and outer coating of the jar after the charging current stops going into the jar? The explanation of this mystery must be looked for in the electricity's own action. As has been already stated, when the first charge of the unit jar passed into the jar D, the flame F was violently affected, showing that most of the first charge of the unit jar passed out of D through the glass, but as each succeeding charge of the unit jar entered the jar D, the flame F became less and less affected, showing that there is in the electricity which entered D some power of contraction which increased in amount as the potential of the electricity within D increased, until, at last, this contracting power had sufficient force to prevent any electricity from passing out through the glass. Now this contracting power can be no other power than that of the electricity's attraction of cohesion for its own particles; and hence it is manifest that electricity is a peculiar kind of matter, because it possesses attraction of cohesion for its own particles, and yet it is not acted on by the law of gravitation. This letter is already too long for your pages, but if its contents do not convince Dr. Shettle that he is wrong in maintaining that electricity is energy and not matter, I may in another letter enter into details in criticising Dr. Shettle's theory of electricity, in the explanation of which he has used a great flow of scientific words which result in the confounding of some scientific facts.—Yours, &c., JAMES JOHNSTONE.

Experiment Rooms, 1, James's-square,
Edinburgh, May, 1882.

DIMENSIONS OF A MAGNETIC POLE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I see on page 27 of your last number that Professor Clausius objects to Maxwell's dimensions of magnetism in the electrostatic system of units, and that he appears to be supported by Professor Everett, the author of a valuable work on units. The argument, as stated by the latter, is that since

$$\text{pole} \times \text{length} = \text{current} \times \text{area},$$

we should have the dimensions of pole = L × dimensions of current. This comes out right in the electro-magnetic system, but quite wrong in the electrostatic.

The error appears to lie in the neglect of the distinction between magnetic force and magnetic induction. The latter is μ times the former, μ being the magnetic "permeability" of the medium. Now, a small plane electric current and a small magnet produce similar fields of force in a particular medium, so we may choose a certain strength of current that shall make the fields of the same strength externally. But a remarkable difference comes in when we change the medium. In the case of the closed current the magnetic force remains always the same, the induction, therefore, varying directly as μ. But with the magnet it is the induction that remains the same, whilst the force varies inversely as μ.

So we have

$$\text{magnetic force} = \frac{\text{current} \times L}{L^2} = \frac{\text{current}}{L},$$

and also

$$\text{magnetic force} = \frac{\text{magnetism}}{L^2 \mu}.$$

Consequently,

$$\text{magnetism} = \text{current} \times L\mu,$$

or $$\text{pole} \times L = \text{current} \times L^2\mu,$$

or $$\text{pole} \times \text{length} = \text{current} \times \text{area} \times \mu,$$

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so that the magnetic moment of the current is really μ times that of Professors Clausius and Everett.

Maxwell determines the dimensions of the quantities from relations in which μ does not appear, and from the ratio of two of them, viz., the magnetic induction and the magnetic force, the dimensions of μ are found to be $\frac{T^2}{L^2}$ in the electrostatic system, and *nil* in the electro-magnetic. This naturally agrees with

$$\text{pole} = \text{current} \times L\mu.$$

A very similar thing occurs in the electro-*magnetic* system if we do not attend to K, the co-efficient of dielectric capacity. Thus, from the dimensions of electricity being $L^{\frac{1}{2}} M^{\frac{1}{2}}$, and from

$$\text{electric potential} = \frac{\text{electricity}}{\text{distance}}$$

we might hastily conclude that the dimensions of potential were $L^{\frac{1}{2}} M^{\frac{1}{2}}$, whereas Maxwell gives $L^{\frac{3}{2}} M^{\frac{1}{2}} T^{-2}$. The explanation is that a given charge in a medium of capacity K gives a force $= \frac{1}{K} \cdot \frac{\text{electricity}}{L^2}$, and, consequently, potential $= \frac{\text{electricity}}{K\,L}$. K being a numeric in the electrostatic system, its neglect does not cause error there, but in the electro-magnetic system relations not containing K should be used. Like μ in the electrostatic system K in the other system has dimensions $\frac{T^2}{L^2}$, the product $K\mu$ being, therefore, $\frac{T^2}{L^2}$ in both systems alike, the reciprocal of the square of Maxwell's velocity of propagation of disturbances.

In Ampère's theory of magnetism, magnetised molecules are simply molecules with currents flowing round them, *i.e.*, small closed currents. But these currents are not of constant strength, but vary according to the magnetic force passing through them from external causes, so as to preserve the amount of indication through them constant. This follows from the currents meeting with no resistance. If a magnetised molecule were replaced by an unchangeable closed current, they would only produce equal external force in some particular medium, and could not be generally exchangeable. —Yours, &c. OLIVER HEAVISIDE.

3, St. Augustine-road, N.W., May 27, 1882.

CURATIVE ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I fail to see how the assertion that "it has never yet been shown that magnetism—even as developed by the most powerful permanent or electro-magnets—exerts any physiological action whatever" can be *partially* correct. Either the fact has been demonstrated or it has not. In Dr. Shettle's letter I find nothing that I can accept as evidence in favour of the affirmative proposition. I am well acquainted with Faraday's experiment, in which currents of electricity are developed by rotating a coil of wire, and I freely admit that these magneto-electric currents are capable of exercising a physiological action; but I cannot perceive how this experiment can be logically quoted "by way of testifying to the influence which terrestrial magnetism exerts upon the blood and tissues of the body." I am also well aware that the animal organism may form part of the magneto-static circuit—*i.e.*, may be traversed by magnetic lines of force, so that a magnetic needle may be affected by another magnet acting through the human body. I have heard also that by making this magnetic needle portion of a "tolerably sensitive galvanometer" the attempt has frequently been made to substantiate the delusive statement that magnetism is equivalent in its effects to currents of electricity. But these facts do not in any way justify the conclusion that the application of magnets to the human frame is attended with the production of any physiological or, possibly, curative effects. In the production of electric currents a conversion of energy invariably occurs, and this energy may be and sometimes has been utilised as beneficially modifying the conditions of animal life. When, however, the animal body is made to form part of a magnetic circuit, not only is it impossible to demonstrate the production of any physiological effect, even with the most powerful magnets, but, if we choose to assume that such effects occur, we are forced to the conclusion that the energy utilised in their production must be that of the vascular or circulatory system, or, in other words, that the arterial and venous flow must be more or less impeded.

Dr. Shettle appeals to experimental results, *inter alia* those which he observed in his own case. To these I am bound to give close and careful consideration. I accept Dr. Shettle's facts without reserve; but I cannot accept the deduction he obviously arrives at from them. Whilst I have a very low opinion of the curative effects of magnets, I have a very high opinion of the beneficial action of *flannel*—especially new flannel—in many of the ailments which flesh is heir to. Has Dr. Shettle tried the flannel without the magnets? If he will substitute for the latter the "pieces of whalebone," I am inclined to "back" the flannel-whalebone combination. I hope even at some future period to give some marvellous cases of cure effected by it. And it may be pertinent to observe that the physiological action of flannel, in stimulating the skin by frictional and probably also by electrical agency, is, unlike that of magnets, beyond any doubt or question.—Yours, &c., DESMOND G. FITZGERALD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent, Mr. Donovan, has failed to perceive that which my words conveyed, viz., that I adduced facts, and not opinions, in substantiation of the value of magnetism as a therapeutic agent.

The laws governing magneto-electricity are bound to hold good whether in a living body or out of it, and until those laws can be set aside magnetism must act in the manner I described in my letter of May 20.

A little consideration of the principles of magneto-electricity will, I am sure, convince Mr. Donovan that his method of conducting his experiments must be fatal to the production of any physical results.—Yours, &c.,

RICHD. C. SHETTLE, M.D.

Reading, May 27, 1882.

STORAGE BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Would the Editor or some subscriber be kind enough to explain how to make and charge storage batteries or accumulators.

I should like them to occupy as small a space as possible, so as to be portable, as I am an amateur, and want them to be handy.

Please say whether a high or low electromotive force dynamo machine is best for charging.—Yours, &c.,

W. BARTON.

Waterloo-place, Hill Foot, Sheffield,
May 29, 1882.

THE GRAMME MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We have now the pleasure to inform you that at a meeting of the directors of the Anglo-American Brush Electric Light Corporation, held at these offices to-day, the following resolution was unanimously adopted, viz.:—"The British Electric Light Company (Limited) having issued notices to several of the licensees for the sale and users of dynamo machines manufactured by the Corporation, which notices claim that such dynamo machines are infringements of the 'Gramme' patent of June, 1870, belonging to the British Electric Light Company, and the directors of this Corporation being advised that such a claim on behalf of the British Electric Light Company is utterly untenable, resolved: That this Corporation is prepared to guarantee the licensees for the sale and users of dynamo machines manufactured by this Corporation against the claim of the British

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Electric Light Company."—Yours, &c. (for the Anglo-American Brush Electric Light Corporation, Limited),
H. W. Tyler, Chairman.
William J. Cordner, Secretary.
Belvedere-road, Lambeth, May 31, 1882.

THE LATE MR. C. HOCKIN.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: As an old school fellow and college friend of the late Mr. Charles Hockin, I have read with much interest and pleasure the appreciative remarks upon him in your issue of the 6th May, and I beg leave to mention one or two circumstances of his early career, omitted in your article. You state rightly that he went to Cambridge from Aldenham Grammar School, but his first school was Mr. Ogle's, Loudoun-road, St. John's Wood (now removed to Sevenoaks), where he had the opportunity of good elementary instruction in natural science from Mr. W. Tegetmeir (now known as an authority on birds). He showed at Cambridge very high mathematical ability, and I was assured on the best authority that, while he appeared only as third wrangler in the Tripos of 1860, yet he was decidedly first in the *Problem* papers, which would, of course, stamp him as the first mathematician of his year. His acquaintance with natural science in general, physical, chemical, and biological, was remarkable. With all this, his modesty, as you say, was conspicuous. He was, too, a most amiable man, and always showed consideration for the feelings of others. I never remember him to have made an invidious or an unkind remark to, or of, anyone. One can well understand that he was a "thorough favourite in his profession." Hoping you will kindly find space for these few lines—Yours, &c.,
A Former Scholar of St. John's.
Arnesby Vicarage, May 31st, 1882.

EDISON'S ELECTRIC METERS.

Mr. F. Jehl, who has long been assisting Mr. Edison in his laboratory work, has recently furnished us with a considerable amount of information in relation to Edison's work on meters. This information is issued in the shape of a pamphlet for private circulation; but, by the author's permission, we are allowed to reproduce that part which is believed to be interesting to general readers. Although we have from time to time referred to Edison's work in this direction, and illustrated his apparatus, as shown at Paris and at the Crystal Palace, it will be best to again describe the instrument, inasmuch as improvements and modifications have been recently introduced. We also give details as to the method of using it.

The meter is divided into two compartments. The first, or the one on the left side, is termed the monthly cell. This is taken out every month by some *employé* of the company, and another cell is substituted for it. The one taken out is returned to the station, where the plate that has received the deposition is weighed. The cell on the right hand of the meter is termed the quarter yearly cell, and is a check cell. The party who inspects the monthly cell has no access to the quarter yearly cell. This quarter yearly cell is taken out every three months and the deposit weighed. Its deposit must bear a certain proportion to the sum of the monthly meter deposit for those three months. If its deposit does not agree in proportion to the monthly cell there is something wrong, or somebody has tampered with it. Thus we see the object of this auxiliary cell. In Fig. 1 A is the monthly cell, and A^1 is the quarter yearly cell. B^1 and B are compensating resistances, the object of which will be explained further on. In the small meters (for 25 lights), the compensating resistance is 7·5 ohms at zero, and all measurements of resistance should be made at zero, or reduced to it. In the large meters (for 50 lights) the compensating resistance amounts to 7· ohms at zero.

C and C^1 are the respective shunts from which the cells A and A^1 receive their current. The shunt C has a resistance of ·01 of an ohm, while the shunt C^1 has a resistance just one-fourth of that, ·0025 of an ohm. We see thus why one cell receives four times as much current as the other, one shunt being four times as large.

D is a thermo arrangement which Mr. Edison has devised in order to prevent the freezing of the sulphate of zinc solution in the winter. It consists of a strip of brass and

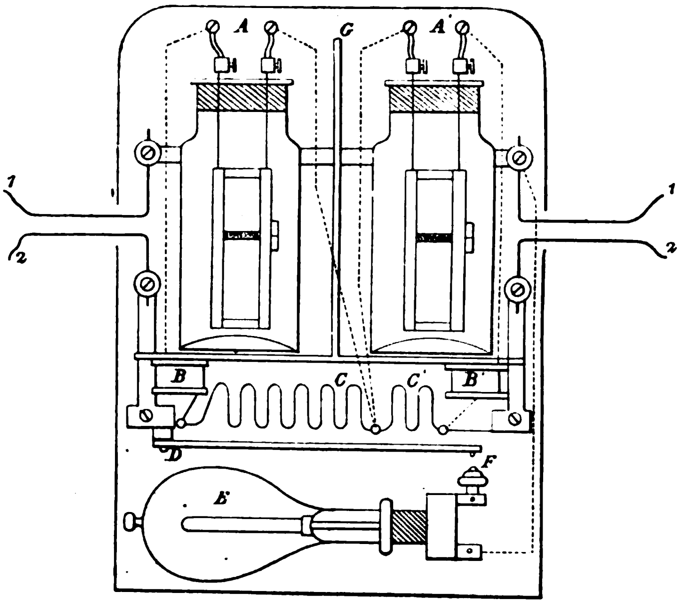

Fig. 1.—Edison's Electric Meters.

steel rivetted well together. Now, one of these two strips expands more than the other. It, therefore, bends in one direc-

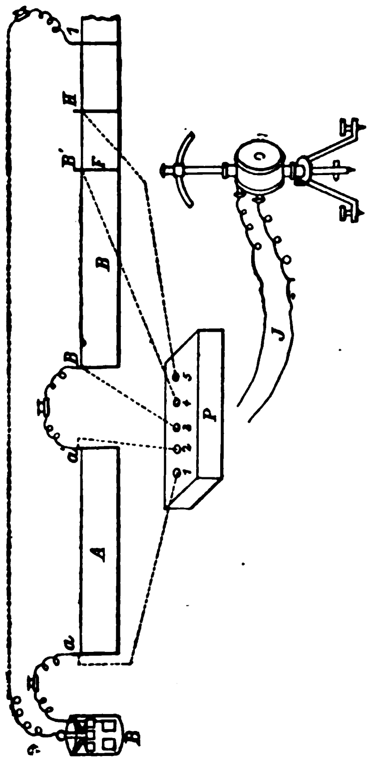

Fig. 2.—Showing Method of Making Meter Shunts.

tion when heated, and as the other strip contracts more than the former when there is a decrease in temperature the combination bends in the opposite direction. It is, therefore, so adjusted, that where the temperature of the atmosphere is about 42° F. it bends and makes contact at the point F, which completes the circuit through the lamp E. The lamp heats the meter, and the heat takes effect on the thermo strip, which then breaks the circuit again, until the heat is dissipated

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1, 1^1, 2, and 2^1 are the places where the main lines enter and return. G is the partition which divides the two cells from each other.

The shunts used in the meters have a resistance of ·01 of an ohm at about 85° F., and simply consist of a band of German silver. It is necessary to adjust each one with a standard resistance, as one cannot rely upon the length, thickness, and breadth of the band, and the alloy is not equally distributed throughout the whole length, nor is its diameter exactly the same at different parts. The best manner to make a shunt is to put a band of German silver in circuit with a standard shunt or a standard resistance, including a battery, and take your deflections with a high resistance reflecting galvanometer. Fig. 2 will illustrate the best plan. Here we have the battery B, which ought to be a constant one, such as a Daniell, with the standard shunt A, and a band of German silver B, which we wish to adjust so as to make it equal to the one A. Connect in series, and the circuit is complete. Now we connect by means of small wires at a and a^1 at the standard shunt the two ends of the reflecting galvanometer G and get a deflection, suppose

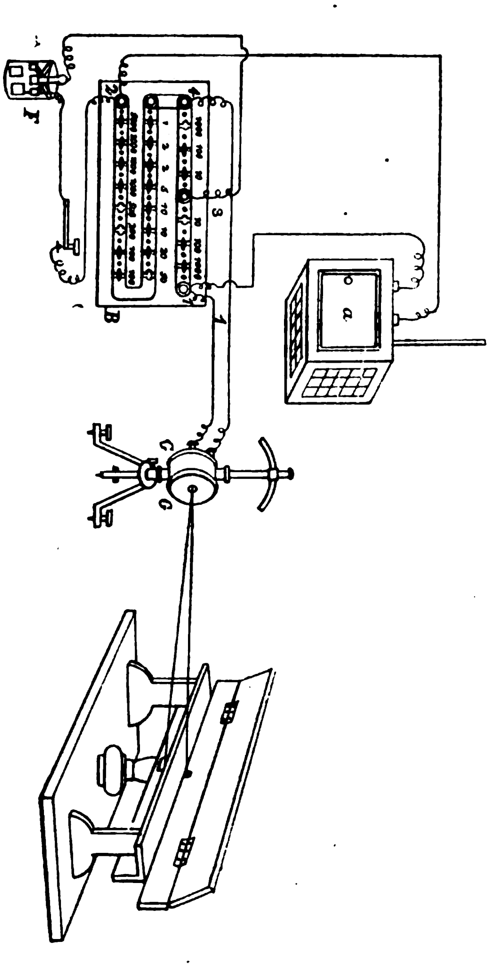

Fig. 3.—Showing Method of Adjusting Compensating Resistances.

300. We then connect the galvanometer to the wires leading to the band of German silver at B and B^1 and notice the deflection. If it be not the same as our standard one, we move the wire F, which is capable of sliding up and down, until we have a deflection equal to the standard. Care should be taken that in handling the band it is not heated by the hand, as the temperature of A should be the same as that of B. Having determined the point which makes both shunts alike, the wire F is then carefully soldered. This is a shunt with a resistance of ·01 of an ohm, but it is also required to have one which equals ·0025 of an ohm. The two shunts are generally made from one strip, for where we leave off on the large shunt we begin with the small one; for instance, having soldered the wire F in the figure, we take another wire with a slit in and place it about H. And another small wire at the point H. Now we get the deflection between B^1 and H, and adjust it so that it gives a deflection one fourth of the deflection given by the standard. P in the figure is a block of paraffin, with 5 holes containing mercury, and the extremities of the wires immersed into them, thereby saving the trouble of connecting the galvanometer terminals with the wires, and also assisting towards great rapidity in manipulation. For one has only to put the ends of the galvanometer into 1 and 2 and we get the deflection between a and a^1; when they are immersed into 3 and 4 we get the deflection between B and B^1; and when into 4 and 5, the deflection between B and H. It may be noticed that before beginning to adjust a strip of German silver, it should be heated to redness over a Bunsen burner, and then the oxydized surface cleaned by immersing it in some dilute nitric acid.

In making and adjusting compensating resistances one must have them in a place where they are not subjected to a variation of temperature, in a small box, for example, where the two extremities lead out as shown in Fig. 3, which also shows how the connections on the Wheatstone bridge are made, when connected for measuring resistance. The box a contains the compensating resistance which we have to adjust, there being a thermometer in the box in order to ascertain the temperature. The two ends of the resistance are then connected to the points 1 and 2 on the bridge, between 3 and 2 a battery is inserted with a key for making and closing the circuit, and between the points 1 and 4 the reflecting galvanometer. Suppose the bridge B at a temperature of 18° per cent., and we also find that our temperature in the box A is 18°. Our compensating resistance must be adjusted to 8·01 ohms if its resistance is or is supposed to be 7·5 ohms at zero. For we know that the difference between 0° and 18° per cent. is on the Fahr. scale 32·4°, and by the table given below we see that the constant for thirty degrees is 1·0650, and for two degrees 1·0042. We, therefore, add the fractional part of the latter to the constant for thirty degrees, which makes

$$1·0650 + ·0042 = 1·0692$$

and this multiplied by 7·5 equals 8·01 ohms.

We can arrive at the same results and with more precision without having to convert Cent. degrees into Fahr. degrees by employing Dr. Mathiessen's formula:—

The resistance R of the metal at the temperature T expressed in degrees Centigrade may be calculated from the resistance $\surd$ at 0° Centigrade.

$$R = \surd(1 + T \cdot 00\ 3824 + \cdot 00000\ 126\ T^2)$$

Thus our resistance at 0° C is 7·5 ohms, and we want to see what it is at 18°. We therefore multiply 18 by ·003824 18. × ·003824 = ·068832; adding 1· we have 1·068832; now adding to this the product of 18^2 by ·00000126 we have 18 × 18 = 324 × ·00000126 = ·000 50824, and this product added to 1·068832 we have

$$\begin{array}{r} 1·068832 \\ ·00050824 \\ \hline 1·069 \end{array}$$

Therefore, our constant is 1·069, and this multiplied by 7·5 = gives about 8·01 ohms. If it were the compensation resistance for the 50 light meters we would multiply the constant 1·069 by 7, which would be 7·48 ohms.

An example may be given of the use of the meter. Thus, say a meter, whose number is 5, was put in Mr. J——'s house, at 57, Holborn-viaduct, on the 20th of March, 1882, and the plate's weight was as follows:—Monthly plate, 90,300 millegrames; the quarterly plate's weight 90,400 millegrammes. Now, at the end of the month, on the 20th of April, the monthly one was taken out and weighed; its weight was 91,400 millegrammes, that being an increase of 1,100 millegrammes, and this, divided by 1,336, gives us the current consumed, which is 823·3.

The following table will help to compute the variation of

resistance of wires at varying temperatures, from a low temperature to a higher one:—

To increase from lower temperature to higher multiply the resistance by the number column 2 (degrees F.)

No. of Degrees.	Column 2.	No. of Degrees.	Column 2.
0	1·	20	1·0428
1	1·0021	21	1·0450
2	1·0042	22	1·0472
3	1·0063	23	1·0494
4	1·0064	24	1·0516
5	1·0084	25	1·0538
6	1·0127	26	1·0561
7	1·0148	27	1·0583
8	1·0169	28	1·0605
9	1·0191	29	1·0627
10	1·0212	30	1·0650
11	1·0233		
12	1·0255		
13	1·0276		
14	1·0298		
15	1·0320		
16	1·0341		
17	1·0363		
18	1·0385		
19	1·0407		

Thus, for example: If we have a resistance of 7 ohms at zero, what would it be at 60 Fahr.? Knowing that zero equals 32 F°, and we wish to find the resistance at 60, there is a difference of 28 deg. between these limits. Multiplying 7 by 1·0605, which is our constant for 28 deg., we have the resistance, $7 \times 1{\cdot}0605 = 7{\cdot}4235$ ohms., which is our answer.

SPRAGUE'S ELECTRIC METER.

The new instruments invented by Mr. Sprague for the purpose of recording the quantity of electricity passing through a circuit are improved applications of the same original principles patented by him in 1878, and which Mr. Edison re-invented in his vebermeter in 1880. These principles, as set forth in the patent of 1878, are "the production of motion in a set of wheels by the agency of plates of metals alternately dissolved and deposited on;" the change of direction of the current being antomatically effected by the weight of metal passed from one plate to the other.

In the original apparatus the electrodes were "suspended by spiral springs, or in any equivalent manner, which will permit them to descend and rise according to their relative weights," while in Mr. Edison's instrument a balance beam was used and spiral springs suggested as an alternative. When the unit weight of metal was deposited, it brought the electrode down so far as to close a contact, by means of which a reversing commutator was actuated, the polar relations of the plates reversed, and at the same time a recording train moved forward one step.

It is evident that these principles permit of an indefinite number of forms of construction, and the new instrument appears to reduce the construction to the utmost limits of simplicity. In fact, all supporting agency is done away with. The moving electrode is simply made to float in the liquid, connection being made to it by a tube containing mercury in which a wire dips, so that the only resistance to motion is the viscosity of the mercury and of the liquids in the cell. The weight of the electrode itself has no longer to be supported, and the metal, as it deposits, merely alters the specific gravity of the electrode, which acts like a hydrometer, and when this addition has sunk it to the defined level, the circuit of the reverser is closed, the metal re-dissolves, the electrode rises to its upper limit, again actuates the reverser and so continues the process *ad libitum*. The electrode and actual deposit may represent only a defined portion of the current, but forms of the instrument are arranged with very large surface, and reversing commutators are constructed of such design as to allow the whole of a large current to pass if desired.

Various subsidiary arrangements are made to meet the various difficulties of applying electrolytic actions to the purpose of electric measurement. As liquids and metals vary in opposite directions in the change of resistance caused by varying temperatures, and as a consequence the relations of shunt circuits will not be constant, a new system is devised by which the metre circuit, consisting of liquid and metal, is compensated by shunt circuits of carbon and German silver, so combined that the variation in resistance by change of temperature is alike in both, and the shunt ratio is therefore preserved unchanged either by external temperature, or by the action of the current itself.

In order to prevent stoppage of the action by freezing of the liquid, a heater is constructed of two glass tubes placed vertically in the liquid, and enclosing between them a wire, which, being heated by the current, warms the liquid. The same appliance is used, if necessary, to produce circulation in the liquid and prevent a dense solution forming at the bottom of the vessel. This is effected by the convection currents set up by the warm surface of the tubes. For warming purposes this heater is actuated automatically by a thermo-regulator, the form preferred being an air thermometer containing mercury and conductor so adjusted that they close the circuit to the heater at an exact limited temperature and open it when that degree is exceeded.

It is singular that Mr. Edison and Mr. Sprague have on several occasions worked out the same idea. To say nothing of the vebermeter, they both patented in 1878, within a few days of each other, an almost identical project for constructing electric lamps, which we noticed at the time. Now again Mr. Edison has patented some improvements in electrometers, one of the claims in which is "The method of maintaining the solution of an electrolytic cell above the freezing point, consisting in heating the same from a carbon or other resistance the circuit of which is made or broken automatically by the fall and rise of temperature." This patent dates seven days later than that of Mr. Sprague. They have also both endeavoured to meet the effects of varying temperature. Mr. Edison balances the liquid and metallic resistances so as to obtain a uniform total resistance in the direct metre circuit. Mr. Sprague adjusts the shunt circuit to vary in proportion with the meter circuit. The effect, of course, is that the proportionality remains constant, and the desired purpose is attained, which is not the case by making the meter circuit a constant resistance united to a shunt circuit, which varies.

Unless in practice there arise difficulties in its application, it would appear that some form of electrolytic decomposition offers the best mode of measuring currents, because this effect of electricity is the only one which is absolute and independent of varying external conditions. The magnetic actions of currents which may be applied for purposes of recording, as they have long been for purposes of indicating currents passing, have not this advantage, as varying friction and metallic expansion must necessarily affect the value of motions generated under magnetic influences, while within very close limits an electric current of a unit value will always effect the same quantity of electrolysis, and as in this meter those actions only are employed which do not absorb energy and set up approving forces there is every reason to expect that it will do its work effectively.

One mode of construction is adapted to use in electrometallurgy. An index is connected with the moving electrode, and traverses a scale graduated to represent the required work, such as ounces of silver or gold. A movable stop is placed at the required position upon the scale, and when the desired quantity of work is accomplished (say the deposit of a given number of ounces of silver in a depositing vat, or a fixed weight of gold upon some large object), the index touches the stop, and thereby closes the circuit, either of a bell to call the attention of the workmen, or of a contact maker, which would cut the work out of the circuit and prevent further deposit. A similar but simpler form is arranged for experimental purposes to act as a voltameter, and enable an observer to watch the action going on in an electric circuit.

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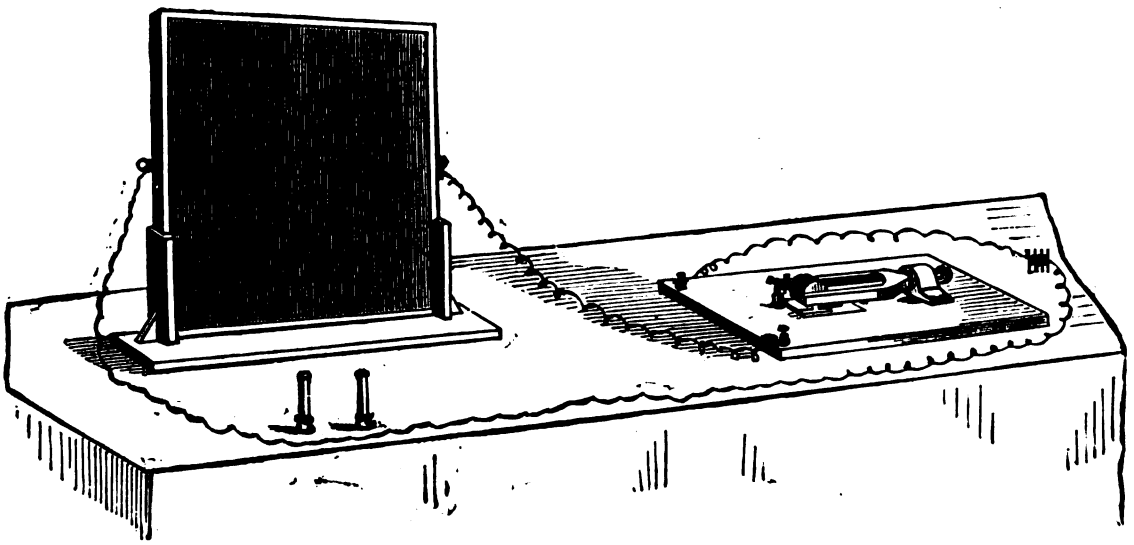
THE INDUCTOPHONE.

We herewith illustrate the apparatus with which Mr. Willoughby Smith has obtained such startling results. We say startling, because although easy of explanation now they are shown, they have not been foreshadowed by any one who has been experimenting in telephony. The apparatus consists of a tuning fork used to obviate the constant presence of an assistant, between the prongs of which is a small electro magnet, and carrying on one prong a small contact piece which makes and breaks contact with a disc carried by the binding screw, shown at the end of the fork. There is another binding screw between the prongs. The connections between the binding screws are underneath the base board. A small battery of Lechanché cells is used. The current is arranged so as to have a make-and-break contact in the main circuit. The frame, which looks like a large looking-glass frame, carries a large flat disc coil of fine insulated wire. This disc coil, when the current goes through it, may be looked upon as a very short magnet, with lines of force radiating from its poles in the manner and directions so well known in connection with magnetism. Hitherto there has been found no substance that will insulate these lines of force. They pass through air, through brick walls, glass, gutta percha, the human body, &c., with equal facility. It is well known that if a piece of iron, steel, &c., be brought within the influence of these lines of force, that is if brought within the field of force, it undergoes a change, and presents phenomena that were previously dormant. Mr. Willoughby Smith found that by bringing the tympanum of an ordinary Bell telephone in the field of force obtained as described, the iron reproduced the sound of the vibrating fork. The results are intensified if the magnet and tympan of the telephone are used in conjunction, the coil being disregarded, it being found to add little or nothing to the phenomena. If a thin disc of ferrotype iron is taken, like the tympan of the telephone, and placed so that the surface of the disc is parallel to the direction of the lines of force, that is, so that no lines of force impinge on the disc, then no sounds are heard; but if the disc is bent so as to cut some of the lines of force, the sound immediately becomes audible. As we have before mentioned, there is no metallic connection between the distributing disc and the telephone disc. The latter may be in the same or another room, and the effects are still obtained. Of course the farther off from the centre of the distributing disc the less intense are the results, as we take the usual law to hold good, and that the influence varies as the square of the distance. The distance to which the lines of force extend has, as yet, not been ascertained. These experiments of Mr. Willoughby Smith prove that the receiving telephone may be altogether independent of the circuit of the sending instrument, so far as regards visible and material connections. All these discoveries point out that

> "There are more things in heaven and earth, Horatio,
> Than are dreamt of in your philosophy."



Willoughby Smith's Inductophone.

THE ELECTRIC LIGHTING BILL.

The Select Committee of the House of Commons appointed to consider the merits of the various measures promoted this Session by gas companies, corporations, and electric lighting companies for the establishment of electric lighting have given their decision in the following resolutions:—

"1. That the Board of Trade be empowered to grant licenses to local authorities, or to private undertakers, with the consent of such local authorities, to supply electricity within a defined area.

"2. That such licenses be for any period not exceeding five years, but may, at the expiration of the license, be renewable with such consent as aforesaid.

"3. That the Board of Trade be empowered to grant provisional orders to local authorities, or to private undertakers, without the consent of such local authorities, for the supply of electricity; but such provisional orders shall be subject to confirmation by Parliament.

"4. That notice of any application for a license or provisional order be given by public advertisement in the district, and full opportunity be given to all parties interested to state their case to the Board of Trade.

"5. That no application for a license or provisional order be granted until the expiration of three months from the notice of such application.

"6. That no application by any local authority for a provisional order under this Act be proceeded with until it has been submitted to a meeting of the local authority, specially summoned for the purpose by public notice.

"7. That licenses and provisional orders should carry with them power to break up the streets for the purpose of laying the necessary wires.

"8. That, where it has been proved to the satisfaction of the Board of Trade that any area as defined by license or provisional order is sufficiently supplied with electric light, and that the supply of gas in such area has ceased to be remunerative, the Board of Trade be empowered to make an order relieving, either wholly or in part, any corporation or gas authority from being compelled to supply gas within such area.

"9. That local authorities be empowered to purchase compulsorily the undertaking of any company or person authorised by provisional order to supply electricity at the end of 15 years, or at the end of any subsequent period of five years.

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"10. That for the purpose of the purchase of the undertaking, the value of the land, buildings, works, materials, and plant shall be deemed to be their fair market value at the time of the purchase, due regard being had to their nature and their condition, to their state of repair, to their suitability to the purposes of the undertaking, and where a part only of the undertaking is purchased, to any loss occasioned by severance, but without any addition in respect of compulsory purchase, or of goodwill, or of any past or future profits, or of any similar consideration.

"11. That licenses and provisional orders should contain such regulations—(*a*) For securing the safety of the public from injury to life, or from fire; (*b*) for inspection; (*c*) for securing a regular and efficient supply of electricity; (*d*) for fair prices—as experience may prove to be necessary; and where it has been proved to the Board of Trade that public safety is likely to be endangered, they shall at all times have power to make such further regulation as may be required for securing the safety of the public.

"12. That overhead wires be forbidden without the consent of the local authority; and where it has been proved to the satisfaction of two justices of the peace or corresponding authority that any such wire is or is likely to become dangerous to the public safety, they may make an order directing it to be removed upon such terms as they may think fit.

"13. That local authorities supplying the electric light be required to keep separate accounts of such undertaking, and to publish them in detail for the information of the ratepayers.

"14. That the Board of Trade be required to submit to Parliament an annual report of their proceedings under this Act.

"15. That any undertakings which may be authorised by private Acts for the supply of electricity be subject to the conditions contained in this Act."

The committee stands adjourned until the 8th of June, when they will receive and consider amendments not contravening the principles of the resolutions at which they have arrived.

REGULATIONS FOR CABLE SHIPS AT SEA.

In reply to the representations of the telegraph companies that there should be some distinctive signals to distinguish vessels engaged in cable work from vessels "not under control," the signals in the Board of Trade regulations having hitherto been the same for both classes of vessels, and having led to danger and inconvenience, the Board of Trade have forwarded to Mr. Pender, M.P., for the information of the companies, "copies of the new Articles 5 and 27, which it is proposed to include in the revised regulations for preventing collisions at sea." They are as follow:—

"Regulations for Preventing Collisions at Sea.

"Art. 5. (*a*) A ship, whether a steamship or a sailing ship, which from any accident is not under command, shall at night carry, in the same position as the white light which steamships are required to carry, and, if a steamship, in place of that light, three red lights in globular lanterns, each not less than ten inches in diameter, in a vertical line, one over the other, not less than three feet apart; and shall by day carry, in a vertical line, one over the other, not less than three feet apart, in front of but not lower than her foremast head, three black balls or shapes, each two feet in diameter.

"(*b*) A ship, whether a steamship or a sailing ship, employed in laying or in picking up a telegraph cable shall at night carry in the same position as the white light which steamships are required to carry, and if a steamship, in place of that light, three lights in globular lanterns, each not less than ten inches in diameter, in a vertical line over one another, not less than three feet apart; the highest and lowest of these lights shall be red, and the middle light shall be white, and they shall be of such a character that the red lights shall be visible at the same distance as the white light. By day she shall carry in a vertical line one over the other, not less than three feet apart, in front of but not lower than her foremast head, three shapes not less than two feet in diameter, of which the top and bottom shall be globular in shape and red in colour, and the middle one diamond in shape and white.

"(*c*) The ships referred to in this article, when not making any way through the water, shall not carry the side lights, but when making way shall carry them.

"(*d*) The lights and shapes required to be shown by this article are to be taken by other ships as signals that the ship showing them is not under command, and cannot, therefore, get out of the way. The signals to be made by ships in distress and requiring assistance are contained in Article 27.

"Signals of Distress.

"Art. 27. Every ship which is in distress and requires assistance shall make use of the signals named in this article.

"In the day-time.—The following signals, numbered 1, 2, and 3, when used, displayed together or separately, shall be deemed to be signals of distress:—

"1. A gun fired at intervals of about a minute;

"2. The International Code signal of distress indicated by N.C;

"3. The distant signal, consisting of a square flag, having either above or below it a ball, or anything resembling a ball.

"At night.—The following signals, numbered 1, 2, 3, when used or displayed together or separately, shall be deemed to be signals of distress.

"1. A gun fired at intervals of about a minute;

"2. Flames on the ship (as from a burning tar barrel, oil barrel, &c.).

"Rockets or shells, throwing stars of any colour or description, fired one at a time, at short intervals."

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

Thursday, May 25.

The President having made an announcement with reference to the offer of prizes for papers read before this society—the particulars of which will be found in another column—Lieut. P. Cardew, R.E., described a new method devised by him of determining large electric currents and very low resistances. Several kinds of apparatus constructed by Lieut. Cardew were exhibited and fully explained, with the results obtained in various experiments to test their efficiency. The main object was to get over the uncertainties attending the use of a standard cell, and this was attained by a modification of, or rather an addition to, the Obach galvanometer, two coils being used in a manner somewhat resembling that suggested at a recent meeting by Professors Ayrton and Perry.

Lieut. Arthur W. Bagnold, R.E., then gave an interesting account of the shipment and operations of the field telegraph corps employed in the Transvaal during the year 1881. The paper chiefly dealt with the restoration and maintenance of the line between Newcastle and Pretoria.

Commenting on Lieut. Cardew's paper, Professor Ayrton said: I have been much interested in the communication which Lieut. Cardew has been so kind as to give us, the more so because Lieut. Cardew has been travelling along some of the lines traversed by Professor Perry and myself in the construction of simple instruments for measuring strong currents and small resistances. When attempting in 1879 to employ the two-coil method for measuring currents, which Lieut. Cardew has more recently adopted, we came to the following difficulty, which I fear Lieut. Cardew will find it not easy to overcome, and it is this. As long as you trust to the weak earth's field to control your suspended needle it is easy enough to have many turns of the fine wire coil close to your suspended magnet, and one or two convolutions of the thick coil farther away, but if to make the instrument dead beat a powerful permanent magnetic field be attached to the instrument, it requires several convolutions of the thick wire traversed by the strong current to be put close to the suspended magnet to produce a deflection, and in that case you cannot approach the fine wire near enough to the magnet for the weaker current to equalise the action of the stronger. We, therefore, abandoned this method, which has been followed by Lieut.

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Cardew, and instead used in our ammeters, as the members are aware, the very same convolutions of wire for the thick coil, and for the thin, the position of the commutator determining the mode of connecting up the wires. Lieut. Cardew's galvanometer for measuring currents is obviously intended rather as a laboratory instrument than as a portable one to be used anywhere, since a new, well made Daniell cell, necessary to be used with it each time a measurement is made cannot be found at an electric light installation, and to carry a large cell such as is on the table about with one would be troublesome. His instrument for measuring small resistances has the same object as the ohmmeter of Professor Perry and myself, but fulfils its object in a different way. He makes the difference between E and C equal to nought, where E is the electromotive force between the two ends of that portion of the circuit of which it is desired to measure the resistance, and C the current in the main circuit, while he measures the actual ratio of E to C or the resistance directly by using not only two coils parallel to one another, but at right angles to one another. With the differential galvanometer of his a balance method is alone possible, for otherwise the zero of his instrument would vary with the strength of the current flowing in the main circuit, and the calibration of such an instrument would be impossible. It appears to me that zero instruments, although they possess considerable sensibility, are unsuitable for quick rough work, since quick changes cannot be measured by them, and I therefore prefer dead beat instruments like our own in which the pointer points to the answer at once, without the necessity of adjusting a screw, or otherwise obtaining balance each time a measurement is made. But I have no doubt that in the laboratory Lieutenant Cardew will obtain most valuable results with his instruments, as they certainly show that he possesses both originality and ingenuity in designing measuring instruments of this class.

With this meeting the session closed.

THE GREAT WESTERN ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of the shareholders of this Company was held at the City Terminus Hotel, Cannon-street, on Tuesday, the 30th ult., for the purpose of considering the propriety of, and, if thought expedient, to expunge Article 40, and the words "or the person entitled to the share by transmission, as the case may be," in Article No. 41, from the Articles of Association.

The undermentioned are copies of Section 40 and 41 of the existing articles:—

Article 40.—"Where any person entitled to a share by transmission, and not having entitled himself according to these presents, either to be registered himself as the holder thereof, or to have his nominee registered, fails for three months after being thereunto required by notice from the directors so to entitle himself, such share may at any time after the expiration of that period be forfeited by a resolution of the directors to that effect."

Article 41.—"When any share has been forfeited in accordance with these presents, notice of the forfeiture shall forthwith be given to the holder of the share, or the person entitled to the share, by transmission, as the case may be, and an entry of such notice having been given, and of the forfeiture with the date thereof, shall forthwith be made in the register of members opposite to the share; but the provisions of this article are directory only, and no forfeiture shall be in any manner invalidated by any omission or neglect to give such notice, or to make such entry as aforesaid."

Mr. H. Russell Evans having been voted to the chair,

The Secretary (Mr. John Parsons) read the notice convening the meeting as above,

The Chairman then said: Gentlemen, you have all had notice of this special meeeing. As you are aware, we have called it for the purpose of complying with the requirements of the Stock Exchange before we get a settlement and quotation for our shares. It was the practice, I believe, in times past to give an undertaking on the part of the solicitor to expunge what the Stock Exchange considered objectionable in the Articles, but for some reason or other they have altered their ruling in that respect, and they now require a meeting absolutely called before they grant a settlement and quotation. He concluded by moving a resolution expunging Article 40 from the Articles of Association of the Company, and afterwards observed: The resolution is merely technical, as you see, to comply with the requirements of the Stock Exchange.

Mr. Stenger (shareholder) formally seconded the resolution, which was carried unanimously.

The Chairman next moved the expunging of the words mentioned from Article 41.

Mr. Simons seconded the motion.

The Chairman put it and declared it carried unanimously, and announced that a further meeting would be necessary to confirm the resolutions.

Mr. Simons inquired if any concessions had been given to any other parties by the Company.

The Chairman: We have sold Devon and Cornwall, and have important negotiations pending for the sale of some other portions of our district which, if carried out, will lead to a very large profit to our shareholders.

A vote of thanks to the chairman closed the proceedings.

BRUSH MIDLAND ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of the members of the above Company was held at the Terminus Hotel, Cannon-street, on the 1st inst., at which the following resolutions were considered:—

1. That the Articles of Association of the above Company be amended by striking out the fortieth Article.

2. That the Article of Association of the above Company numbered forty-one, be amended by striking out the following words in the third and fourth lines of the said Article, namely:—"or the person entitled to the share by transmission as the case may be."

3. That the Article of Association of the above Company numbered 112, be amended by striking out the words "or otherwise interested" occurring in the fifth line of the said Article.

Mr. James Whitehead presided.

The Secretary (Mr. H. N. Myers) having read the notice convening the meeting,

The Chairman said: Gentlemen, the meeting to-day is of a formal character. It is known to most of you, I daresay, that before you can obtain a settlement and quotation on the Stock Exchange the committee of that body go very carefully through the Articles of Association on behalf of shareholders and the public who are interested in any given company. They have done so in the case of this Company, and there are two Articles to which they took exception. I may say that the exception they took to them met entirely with the approbation of the whole of the directors of this Company, and in accordance with the suggestion made to us, and made entirely in concurrence with the opinion of our legal advisers, we recommend the shareholders to-day to pass resolutions with the view of carrying out the alterations suggested. It is unnecessary for me, I think, to detain you at any length by any explanation, because it is quite clear on the face of it what the object of the alterations is. He concluded by moving the first resolution as above mentioned.

Mr. John Parsons seconded the motion, and it was carried unanimously.

On the motion of the Chairman, seconded by Mr. Jolin, the second resolution was passed; and the third resolution was passed on the motion of the Chairman, seconded by Mr. Richard Glyn.

A vote of thanks to the Chairman terminated the proceedings.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices May 31.		Business Done Week Ending May 31. Highest.	Lowest
Anglo-American	54½,	54¾	55	54⅜
Do. Preferred	86½,	86¾	87¼	86½
Do. Deferred	24¼,	24¾	25	24½
Brazil Submarine	11¼,	11⅝	11½	11⅛
Cuba	8½,	9	—	—
Do. Preference	15½,	16½	16¾	16
Direct Spanish	6,	6½	6½	6
Do. Preference	15½,	16½	16	15⅞
Direct United States Cable	12¼,	12⅜	12½	11⅞
Eastern Telegraph	10⅛,	10⅜	10⅜	10 3-16
Do. 6 per Cent. Preference	12⅞,	13⅛	13¼	12⅞
Do. 5 per Cent. Debentures, 1899	102,	107	—	—
Eastern Extension	11⅜,	11⅝	11¼	11 5-16
German Union	9⅜,	10	—	—
Globe Telegraph and Trust Company.	6⅝,	6⅞	6½	6⅞
Do. Preference	12⅛,	12⅜	12¾	12¼
Great Northern	12¾,	13¼	12 15-16	—
Indo-European	28,	29	29	—
Mediterranean Extension	2,	2½	8¾	—
Do. Preference	8½,	9	—	—
Reuter's	12¼,	13¼	13¼	—
Submarine	265,	275	—	—
West India and Panama	1¾,	2	1 13-16	—
Do. 1st Preference	8½,	8¾	—	—
Western Brazilian	7¼	7½	7⅜	—
West. Union 7 per Cent. 1st Mortgage	121,	126	121½	124
Do. 6 per Cent. Sterling Bonds	102,	105	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1¾,	2	2¼	1 15-16
Oriental	⅝,	¾	¾	⅝
United Telephone	15,	15½	15½	15

ELECTRIC LIGHT.

Electric Light and Power	1⅛,	1¼	15-16	1 1-16
Anglo-American Brush (£4 paid)	22½,	23	21⅝	20⅝

Mr. Webb's Entertainment.—Mr. Webb regrets that he has been compelled to postpone his entertainment, which was to have taken place at St. George's Hall on Wednesday afternoon last, until Wednesday, the 7th inst., when all tickets will be available.

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

2484. NEUTRALISATION OF CURRENTS IN TELEGRAPH AND TELEPHONE LINES, *W. P. Thompson, Liverpool.—June 8th*, 1881.—(*A communication from F. V. Rysselberghe, Brussels.*)—(*Not proceeded with.*) 2*d.*

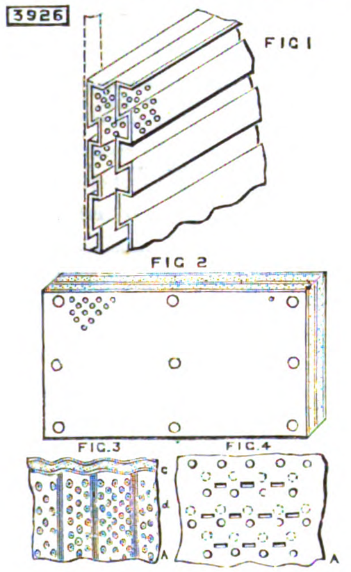
The reception coils are made of enormous resistance compared with the line, hence, the inventor states, the inductive currents will be practically neutralised.

2592. IMPROVEMENTS IN THE MANUFACTURE OF TELEGRAPHIC OR TELEPHONIC CONDUCTORS, &c., *W. R. Lake, London.—14th June*, 1881.—(*A communication from H. A. Clark, Boston, U.S.A.*) 6*d.*

This invention relates to a machine adapted for coating wires with insulating material, which is so constructed that the material is forced through the die opening as the wire proceeds through the same, giving direction to the coating material in the line along which it passes through the die, opening before it reaches the wire it is to coat. It is thus prevented from working itself in a backward direction upon the wire. This, it is claimed, is an advantage where the wire may have previously been coated. The invention also relates to a compound cable for telephonic or other purposes, in which the wires are all at the same distance from and parallel with each other.

3926. SECONDARY BATTERIES OR MAGAZINES OF ELECTRICITY, *J. S. Sellon.—10th September*, 1881. 6*d.*

The electrodes are of lead or other suitable material, which are, or may be, coated with, or have attached to, or packed therein, spongy, precipitated, or reduced lead, &c. The lead electrodes are perforated, serrated, grooved, or corrugated, and the claim is the construction of secondary batteries of perforated plates or sheets, roughened, serrated, or indented, composed of lead, platinum, or carbon, upon, in, or against which plates spongy or finely divided lead or oxides, or other salts or compounds of lead, or other suitable substances or compounds, are, or may be, held. The figures show some forms adopted.



2612. IMPROVEMENTS IN THE CONSTRUCTION OF ELECTRIC LAMPS AND APPARATUS FOR ELECTRIC LIGHTING, *W. Crookes.—15th June*, 1881. 4*d.*

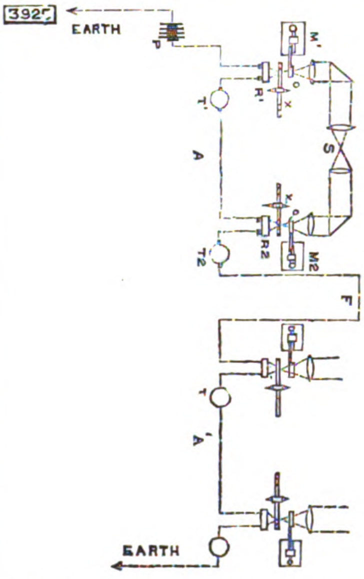
After purifying the material to form the carbon filament from silica, it is treated with cuprammonia to destroy its structure. The copper is afterwards extracted. Modified methods are described.

2658. APPARATUS FOR SAVING LIFE AND PROPERTY AT SEA, *A. D. Roth, Blackheath.—17th June*, 1881. 6*d.*

This consists in the general construction of a safety and signal buoy; secondly, in coating such buoys with luminous paint and fitting them with lights and light-reflecting signals in combination with another mode of signalling, and the adaptation of electric action for the purpose of sight and sound signalling on such buoys.

3929. AN IMPROVED SYSTEM OF MULTIPLEX AND SELF-REVERTABLE "TELERADIOPHONE," *E. J. P. Mercadier, Paris.—10th September*, 1881. 10*d.*

This invention refers to a system of telegraphing, in which the signals are produced by radiophonic effects. The figure shows two stations A and A¹ separated by a long line F, in which two sets of transmitting and receiving apparatus are arranged. A continuous current from battery P passes successively from station A, through radiophonic receiver and telephone R^1 T^1, to R^2 and T^2, &c., by line F. In front of each receiver, made of selenium, lamp-black, &c., are situated the openings of a wheel, rotating rapidly and continuously round an axis X. A diaphragm O of the same size as opening in



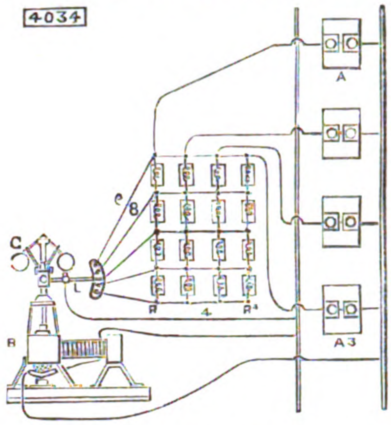
wheel is fixed to a rigid shaft forming a prolongation of key lever M^1, and when at rest closes the openings, thereby checking the radiations from source S. The movement of M^1 consequently alternately allows and prevents the passage of radiations to selenium receiver R^1, and produces variations in its resistance, and therefore in the intensity of the current passing through said receiver. There is, therefore, produced in all the telephones T^1, &c., a musical sound, the pitch of which is determined by the rate of turning of the wheel opposite the respective receivers. It is thus possible to transmit Morse signals acoustically. The figure shows the various arrangements of lenses and specula for conveying the light from source S to the receivers. Various modifications of the above with details of the apparatus are described and illustrated in the specification.

4057. IMPROVEMENTS IN THE PRODUCTION AND EMPLOYMENT OF CONTINUOUS ELECTRIC CURRENTS IN RAILWAY CARRIAGES, &c., AND IN APPARATUS USED THEREFOR, &c., *H. E. Newton, London.—20th September*, 1881.—(*A communication from the Société Universelle d'Electricité Tommasi, Paris.*) 6*d.*

This consists in the combination of a dynamo-machine driven by belting from the axle of the carriage in which it is placed, with a secondary battery, an interrupter, and electric lamps, in such a way that a continuous current shall be supplied to the lamps even though the train be at a standstill, and, consequently, the dynamo-machine also.

4034. IMPROVEMENTS IN AND CONNECTED WITH DYNAMO OR MAGNETO-ELECTRIC MACHINES AND ELECTRO-MOTORS, *P. Jensen, London. 19th September*, 1881.—(*A communication from T. A. Edison, Menlo Park, New Jersey. U.S.*) 6*d.*

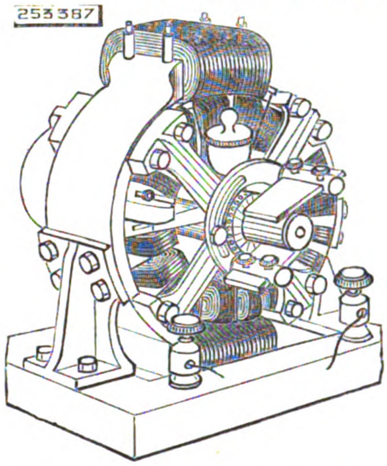
The object of this invention is to regulate the generating capacity of dynamo machines. One method of doing this is shown in the figure. A to A^3 are Edison machines connected in multiple arc; B is an electric engine in a shunt circuit. Upon the shaft of its armature is a governor, G, to which is connected switch lever, L. The speed of armature and governor depends upon the current in the shunt and main circuit. If the current is too little the speed falls, governor balls



drop, moving L into contact with 8 or 9, cutting them out of circuit, and causing an increased current through the field coils, and consequent increase of generative capacity. R to R^3 are resistance boxes.

253,387. DYNAMO-ELECTRIC MACHINE, *Chas. A. Hussey New York N.Y., assignor to the Hussey Electric Company, same place.—Filed August 13th*, 1880.

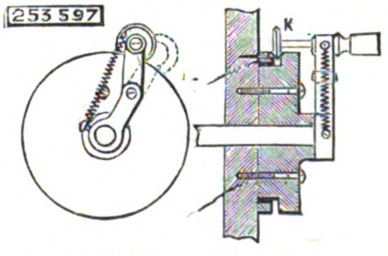
Brief.—The field magnet is circular, inclosing the armature, and has the portion upon which the



wire is wound offset, so that the inner surface of the coil is flush with the inner surface of the polar portions.

253,597. TELEPHONE SIGNAL GENERATOR, *James F. Gilleland, Indianapolis, Ind., Assignor to the Gilleland Electric Manufacturing Company, same place.—Filed January 3d*, 1881.

Claim.—(1) The combination of two insulated contact plates, with an extensible spring-retracted crank carrying a contact plug, substantially as specified. (2) The combination, in a magneto-electric machine, of a crank consisting of arms pivotted together, a contact piece carried by the outer arm, and a retractible spring, whereby the shunt circuit is closed when the crank is at rest,



and opened and held open automically when power is applied to turn the crank. (3) The combination of an extensible spring-retracted crank, with metallic disc K, and insulated contact plates so placed as to form a groove, in which said disc is held by the spring when the crank is at rest, so as to close the shunt circuit around the armature, said disc, when power is applied to the crank, being lifted from the groove, so as to open and hold open the shunt.

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THE

SCHOOL OF TELEGRAPHY & ELECTRICAL ENGINEERING.

ESTABLISHED IN 1868.

12, PRINCES STREET, CORNER OF HANOVER SQUARE, LONDON, W.

(Removed from 4, George Street, Hanover Square.)

MANAGING DIRECTOR: Mr. T. J. JONES, M.S.T.E.

The course of Practical and Theoretical Instruction in the higher branches of Overland and Submarine Telegraphy embraces, in addition to the manipulation of he various systems of working in general use, the following subjects:—

MATHEMATICS, MECHANICS, and CHEMISTRY. } In relation to Telegraphy.	SIGNALLING and TESTING INSTRUMENTS.	ELECTRO-STATICS.	METHODS of TESTING the ELECTRICAL CONDITION of a LINE During and After its Construction.
	ENGINEERING FORMULÆ and their Application in Practice.	ELECTRO-DYNAMICS.	TESTING FOR and LOCALISING FAULTS, &c., &c., &c.
		MAGNETISM.	

The instruction, both in signalling and testing, is of a thoroughly practical character, as the classes work with the actual instruments used on long lines, through cables of various lengths, from 600 to 3,000 knots, so that the signals of the Eastern, Atlantic, and Brazilian Co.'s, &c., are exactly reproduced, and the pupils fitted for any line.

A complete practical and theoretical course of instruction on the TELEPHONE and the ELECTRIC LIGHT, and their commercial utilisation, has now been added to, and embodied in, the ordinary curriculum, as the advantage of being associated with any great commercial application of science at an early period of its development is one which has been so often exemplified that it can scarcely fail to be appreciated by those who have in view professional success.

That **TELEPHONIC** communication and **ELECTRIC LIGHTING** constitute such applications is sufficiently shown by their rapidly increasing progress; and therefore no pains or expense have been spared to place at the disposal of the pupils the technical and scientific instruction requisite to qualify candidates for the most important posts in connection with these new branches of electrical engineering. In order that the instruction in the erection, adjustment, testing, and working of **TELEPHONE** and **ELECTRIC LIGHT** circuits may also be thoroughly practical, complete working telephone exchanges upon the various systems in use in different countries have been fitted up; every kind of telephone, for both exchange systems and private lines, with all apparatus used therewith, is provided (in duplicate when possible, so that students may be able to dissect and reconstruct the same). The necessary tools and materials are available, and every facility is given for conducting experiments by the pupils desirous of so doing, and a similar course is being pursued with the **VARIOUS LAMPS** and **MACHINES, &c.,** in the **ELECTRIC LIGHT** Department, so that pupils from the School are in a position to enter either of these new fields.

The complete Practical and Theoretical course extends over a period of Six Months.

Arrangements have been made so that Inventors, Amateurs, and others can now have every facility, with all necessary apparatus provided in private rooms, to compare, test, or perfect any Inventions, Apparatus, &c., connected with Telegraphy, Telephony, and the Electric Light. Financial and the highest profession' assistance can also be had.

Further particulars may be obtained on application to W. N. TIDDY, *Secretary.*

THE EXCHANGE TELEGRAPH COMPANY, LIMITED.

Head Offices--17 & 18, Cornhill, E.C.; Stock Exchange, E.C.; 27, Regent Street, W.

Incorporated the 28th March, 1872, under the Companies Acts of 1862 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

Not having any springs or clockwork to wind up or to depend on, these instruments are acknowledged by those familiar with the system of telegraphy to be the only instruments yet invented that are capable of doing the work required of them continuously for a lengthened period, as evidenced by the fact that the Gold and Stock Company of New York, having the monopoly of this kind of business in the States, and which owns all the patents of the day of any value, has, after due trial, discarded all others.

The Company is prepared to treat with provincial Companies requiring instruments for the delivery of news for either single or double wire systems under the Company's patents, whereby from central stations identical information can be simultaneously delivered to any number of recipients by automatic, self-adjusting, printing instruments requiring no local batteries, no winding up, and no knowledge of telegraphy on the part of the receiver, the printing being in bold roman type, and the propulsion of the paper being effected by the electricity supplied from the Central Office.

The instruments supplied by the Company can be had to work either on single or double wires, and to print either on a slip or tape of paper, as has hitherto been the custom, or on a broad band of paper in column form.

THE NEW MATERIAL

For ENGINEERS (Sanitary and Hydraulic), ELECTRICIANS, AXLE MAKERS, BRASSFOUNDERS, PUMP MAKERS, RAILWAY COMPANIES, CARRIAGE and WAGGON BUILDERS, &c.

SUBSTITUTE FOR LEATHER, RUBBER, AND PERCHA.

It is unequalled for Washers of all kinds, Hot and Cold Water Packings and Plumbers' uses generally, Insulators, &c.

THE PATENT VULCANISED FIBRE

Is supplied in Sheets from 1-32in. to 1in. in thickness, and in two qualities: Flexible, 2s. per lb.; Hard, 2s. 3d. per lb.

MOSSES & MITCHELL, 62, QUEEN VICTORIA STREET, LONDON.

VESTRY of ST. GILES, CAMBERWELL.—To ELECTRIC LIGHT COMPANIES and OTHERS.—The General Purposes Committee of the above Vestry will meet at the Vestry Hall, Peckham-road, on MONDAY, the 12th June prox, to receive TENDERS for LIGHTING by means of ELECTRICITY as an experiment.

Tenders to be in accordance with Specification and conditions to be obtained at the Surveyor's Office, Vestry Hall, on and after WEDNESDAY, the 31st inst.

Tenders must be sealed and endorsed "Tender for Electric Lighting," to be delivered at the Vestry Hall not later than 5 o'clock on the 12th of June aforesaid.

The Vestry does not bind itself to accept the lowest or any Tender.

By order,

GEO. W. MARSDEN, Vestry Clerk.

Vestry Hall, Camberwell, 26th May, 1882.

WANTED, a thoroughly practical ELECTRICIAN, or ENGINEER well up in electricity, to undertake the management and development of an Electric Lighting Department with a Company who are in possession of certain patents for electric lamps. Address, by letter, 411, Oxford-street, W.

TO ELECTRIC LIGHT COMPANIES and Others.—To LET, a large and splendidly lighted lofty BASEMENT and GROUND FLOOR as warehouse or factory and offices. Corner building in important thoroughfares. Two entrances. Superficial area about 3,600 feet. Steam power can be borrowed at a moderate cost. Rent, including rates and taxes (only) £250.—Apply to Mr. T. HYDE, Hatton Garden Steam Works (near Clerkenwell-road), E.C.

TO ELECTRIC LIGHT COMPANIES.—A Mem. Inst. C.E. having over 20 years' experience in public works, and nearly three years in electrical operations with the dynamo machine, desires EMPLOYMENT. Ample references.

Address, C., office of this Paper.

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SLIP

Brazilian Submarine Telegraph Company. — The traffic receipts of this company, for the week ended 2nd June, amounted to £3,390.

Brush Midland Electric Light Company. — Mr. Martin Fradd has been appointed manager of this company, and Mr. Vyle chief electrician.

Electric Railway at the Crystal Palace.—We believe that an electric railway is shortly to be constructed in the grounds of the Crystal Palace.

Telegrams for China.—The Amoy-Shanghai cable being restored telegrams for Shanghai are accepted as usual for transmission by the Eastern Telegraph Company.

South Eastern and Provincial Brush Electric Light Companies.—Mr. Joseph S. Beeman, A.M.I.C.E., M.S.T.E., has been appointed engineer and electrician to these companies.

Electric Light in Clerkenwell.—At the last meeting of the Clerkenwell Vestry it was stated that arrangements had been made for the electric lighting to be commenced in the parish at Midsummer.

West India and Panama Telegraph Company.—The estimated traffic receipts of this company for the half-month ended May 31 amounted to £3,305, as compared with £2,759 in the corresponding period of 1881.

Eastern Extension Telegraph Company.—The traffic receipts of this company for the month of May, 1882, amounted to £33,087, and to £29,523 for the corresponding period of 1881, being an increase of £3,564.

The Channel Tunnel.—The electric lights hitherto used in the Channel Tunnel works have been abandoned for the present, and ordinary candles returned to, as the engine used as a motor is now employed on other work.

Fire Caused by Lightning.—The Poor House in the small town of Oesthamman, in Sweden, was set on fire by lightning and burnt to the ground on the 1st of June. Out of fifty-two inmates twenty perished in the flames.

Interim Dividend.—The directors of the Brazilian Submarine Telegraph Company (Limited) have declared an interim dividend of 3s. per share, or 6 per cent. per annum, free of income-tax, for the quarter ended March 31 last.

Cable Repaired.—The Great Northern Telegraph Company notify the repair of their Amoy-Shanghai cable, in consequence of which telegrams for all stations in China and Japan are again accepted for transmission by this company's route.

London Platino Brazilian Telegraph Company.—The revenue of this company for the month of February is estimated at £2,194 (Western Brazilian portion £1,563, Land Lines £631), as against £2,010 for the corresponding period of 1881.

Cuba Submarine Telegraph Company.—The number of messages passing over the lines of this company during the month of May was 3,408, estimated to produce £3,300, against 2,979 messages, producing £3,021, in the corresponding month of last year.

Telegrams for South America.—The cables between St. Vincent and Pernambuco, between Bahia and Rio de Janeiro, and between Pernambuco and Maranham, are now repaired; and communication is therefore restored with all parts of South America.

The Royal Society of Edinburgh.—The council of this society has awarded the Keith Prize, for the biennial period 1879-81, to Professor Chrystal, for his paper "On the Differential Telephone," published in the society's *Transactions* for the session 1879-80.

The Electric Light and Power Generator Company.—We understand that this company has received instructions to light up the Botanical Gardens with the electric light (Maxim incandescent and Weston arc lights) on the occasion of the annual *fête* on the 22nd of June.

Western and Brazilian Telegraph Company.—The traffic receipts of this company for the five weeks ending 26th May amounted to £8,550, and for the week ending 2nd June, 1882, to £2,441, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

Electric Lighting for the City.—The consideration of the tenders sent in for lighting the city for one year from 1st October next, which were invited a few weeks back, and were to be sent in by the 12th May, has been postponed pending the passing of the electric lighting Bill now before Parliament.

Petition for Winding up a Company.—A petition has been presented by the Anglo-American Brush Corporation in the Court of Session, Edinburgh, for the winding up of the Scottish Brush Electric Light and Power Corporation. It is said that the shareholders of the latter company are unanimously opposed to this proceeding.

Metropolitan Brush Electric Light Company.—We understand that Mr. Robert Hammond has agreed to join the Board of the Metropolitan "Brush" Electric Light and Power Company (Limited), a working arrangement having been entered into between that Company and the Hammond Electric Light and Power Supply Company (Limited).

The Charing Cross Electric Railway.—The Bill for this railway, which was declared not to have complied with the standing orders by the Lords' Examiner on a technical point, came before the Lords' Committee on Standing Orders last week. The defect having been remedied by the promoters, the Bill was declared to have complied with the standing orders.

An Electrical Railway at St. Louis.—According to an American contemporary the town of St. Louis is shortly to have an electric railway. It will be half a mile long, and will be constructed in the piece of ground known as the "agricultural field." The railway will be constructed by Mr. Heisler, an electrician of St. Louis, and will be on the same principles as a model exhibited by him at the St. Louis Fair in 1878.

Electric Light at Cardiff.—During last week the exterior of the offices of the *Western Mail* in Cardiff were illuminated by means of nine arc lamps. Two of these were placed on a tall flagstaff on the top of the building, and could be clearly seen from the neighbouring towns of Penarth, Llandaff, &c. The occasion of the illumination was the holding of the Bath and West of England Society's Exhibition in the town.

Central and South American Cable.—The India Rubber, Gutta Percha, and Telegraph Works Company (Limited) have received a telegram from their engineer, Mr. Robert Kaye Gray, on board their steamer "Silvertown,"

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announcing the completion of the third section, 483 nautical miles in length, of the Central and South American Telegraph Company's cable—namely, that from Santa Elena, in Ecuador, to Buenaventura, in the United States of Colombia.

Electric Light on a Channel Steamer.—The paddle steamer, "Brittany," was launched from Messrs. John Elder and Co.'s Fairfield Works, on the Clyde, last week. She is one of two vessels being constructed by this firm for the London, Brighton, and South Coast, and the Western of France Railway Companies. She will be fitted with every convenience, including electric lights and electric bells. She was christened by Mrs. Knight, wife of Mr. J. P. Knight, well known as the able general manager of the first of the above-named companies.

Electric Light in Salford.—Messrs. Mather and Platt, engineers, of Salford, are now lighting up a portion of their works by means of Edison lamps, and we believe that it is their intention to greatly increase the number now in use. At present the firm have 81 lamps in their workshops and 53 in their offices, or a total of 134 lamps. The current is generated by two dynamos, driven by two single-cylinder engines of 6 h.-p. nominal. In the offices the lights are fitted in special chandeliers, but in the workshops they are attached to the present gas-pipes.

Society of Telegraph Engineers and of Electricians. — The President of this society, Lieut.-Colonel Webber, has issued invitations to the members to visit the School of Military Engineering at Chatham on the 11th of July, permission to do so having been granted by Brigadier-General Sir Evelyn Wood, V.C., G.C.M.G., &c., commanding the Chatham District. A special train will be provided for the convenience of those who may wish to be present by the London, Chatham, and Dover Railway Company, and will leave Victoria at 11:34 a.m., Holborn at 11:32, and Herne Hill at 11:47, returning from Chatham so as to reach London by 7:18 p.m.

Electric Light on Board Ship.—The arrival of the "Ghoorka," a new steamer recently built for the British India Steam Navigation Company by Messrs. Denny, of Dumbarton, at Scapa, in the Orkney Islands, on a pleasure trip, with Mr. Mackinnon, the chairman of the company and others on board, aroused no little excitement amongst the inhabitants of that part of the islands. The vessel is fitted with the electric light, and this was the first time that such means of illumination had been seen by the inhabitants, many of whom availed themselves of the opportunity to visit the vessel. The "Ghoorka" is to leave London on her first voyage to India on the 28th of this month.

Burglars and Electric Bells.—Two men were brought up at the Dale-street police court, Liverpool, last week, charged with breaking into the premises of some timber merchants in Camden-street, on Whit Sunday morning. The premises were, however, fitted with an electric bell, fixed in such a manner that the door could not be opened without ringing the bell, although it was placed too far away for persons entering to hear it sound. The bell gave the alarm, the police were communicated with, and the prisoners caught redhanded. They were committed to the assizes for trial. A few such cases of prompt capture, and burglars may begin to find that other and more honest means of getting a livelihood are preferable.

New Companies.—W. T. Henley's Electric Light and Power Company has been formed to acquire the patents of Mr. W. T. Henley. It has a capital of £100,000.—The Electrical Share Trust (Limited) has been formed with a capital of £500,000 to extend the trust principle to investments in electric light, telegraph, and telephone companies.—The prospectus is issued of the "Standard" (Fyfe-Main) Electric Lighting and Construction Company (Limited), with a capital of £500,000 in £5 shares, of which the first issue is £300,000. The company is formed to acquire the sole right to the "Standard" arc light system of electric lighting for all parts of the world where patents may be obtainable. The price to be paid to the vendors is £70,000 in cash and £100,000 in fully-paid shares.

Time Signalling.—The following information, relating to time signalling in England, is taken from the report of the Astronomer Royal for 1881:—"There has been only one case of accidental failure in the automatic drop of the Greenwich time-ball. On four days the ball was not raised on account of the violence of the wind. The Deal ball has been dropped automatically at 1h. on every day throughout the year, with the exception of 15 days, on which there was either failure in the telegraphic connection or interruption from telegraphic signals continuing up to 1h., and of one day when the current was too weak to release the trigger without the attendant's assistance. On three days high wind made it imprudent to raise the ball. The Westminster clock has continued to perform well, its errors having been under one second on 40 per cent. of the days of observation; between one second and two seconds on 44 per cent.; between two seconds and three seconds on 14 per cent.; and between three seconds and four seconds on 2 per cent. Time signals originating in the Observatory are distributed at 10 a.m. and 1 p.m. to all parts of the country by the Post Office telegraphs."

The Telephone Case.—A circular has been issued in Scotland by the United Telephone Company, stating that in in the case against Alexander MacLean judgment was pronounced by Lord MacLaren sustaining the validity of Bell's and Edison's patents, and that an interdict was granted against MacLean for infringement of both the above patents. The circular then goes on to say:—"We are informed that you are using both a Receiving and Transmitting Instrument, which are infringements of the Patents above referred to, without any license from the United Telephone Company (Limited), or those empowered by them to grant licenses. It is not wished to act harshly towards those who have in ignorance of the Company's rights rendered themselves liable to an action for damages, and we are therefore instructed to inform you that if the Instruments which you use are given up within one week from this date to the Licensees or Agents of the United Telephone Company, viz., the National Telephone Company (Limited) at the address given below, and if, at the same time, the name and address of the person from whom you purchased the Instruments are furnished, no claim for damages will be made against you."

Magnetic Declination.—According to the report of the Astronomer Royal for 1881, just issued, the following are the principal results for magnetic elements for 1881:—Approximate mean westerly declination, 18° 27′; mean horizontal force, 3·915 in English units, 1·805 in metric units; mean dip, 67° 33′ 45″ by nine-inch needles, 67° 34′ 54″ by six-inch needles, and 67° 35′ 5″ by three-inch needles. The magnetic declination for January 1, 1882, was, on the authority of Mr. William Ellis, 18° 25′ west, and the dip 67° 34′. In his report the Astronomer Royal remarks:—"On September 12 and 13 and April 16 and 19 magnetic storms have occurred, the latter being of more marked character than any that have taken place since the great storms of the year 1872, and it is a significant fact that exceptionally large spots

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made their appearance on the sun shortly before. Smaller magnetic movements are now also much more frequent, exhibiting a marked contrast to their general appearance some two or three years ago. In regard to the long period variation of about 11 years, it can now be stated definitely that the minimum as regards diurnal range of declination occurred at the commencement of 1879, while, as regards diurnal range of horizontal force, it occurred unmistakably earlier, about August, 1878."

THE POSTAL AND TELEGRAPH BENEVOLENT SOCIETY.—The annual meeting of the United Kingdom Postal and Telegraph Services Benevolent Society was held in Manchester on Monday. Delegates were present from London, Birmingham, Leicester, Manchester, Bristol, Leeds, Normanton, Shrewsbury, Rotherham, Huddersfield, Swansea, Liverpool, Crewe, Stafford, Northampton, Oldham, and other towns.—The annual report and balance-sheet showed that during the year a sum of £4,490 had been paid to the nominees of sixty-five members who had died in benefit, making a total of £16,490 since the establishment of the society. During the year 574 new members were enrolled.—Propositions were made by delegates representing offices in different parts of the country with the object of altering the rules so as to bring the benefits of the society within the reach of a larger number of candidates, and a resolution was passed by which members of the postal and telegraph service can insure their lives on more advantageous terms than have yet been available.—A proposition that a levy of 2d. from each member of the society should be made, with the object of creating a fund to enable the Central Secretary to make immediate grants in case of a member's death, was withdrawn, after a statement that no case had arisen requiring such a provision.—The newspaper branch in the London office brought forward a proposition that, with a view to the future stability of the society, it was necessary to establish a guarantee fund, but after a long debate the proposition was rejected. The meeting carried several propositions for revising the rules; and in the evening dined together at the Grosvenor Hotel.

ELECTRIC LIGHT IN THE HOUSE OF ASSEMBLY, CAPE TOWN.—The Cape *Times* of the 11th May says:—"The House of Assembly was publicly lighted for the first time last evening by the electric lighting apparatus which has been fitted up by a representative of Mr. Edison, the celebrated American inventor. The light was tried on the previous evening and the result proved quite satisfactory. At five o'clock yesterday afternoon the light was turned on without any previous warning, and before hon. members recovered from the surprise occasioned by the novel sight, the House was illuminated by the beautifully bright and steady glow of the forty-four lights placed along the walls. There are thirty-four of these lights in the body of the House, and ten in the public gallery. The present experiment has been undertaken by Mr. Edison, at the instance of the Colonial Government, with the view of enabling them to decide whether it is expedient to introduce the electric light into the New Houses of Parliament. The apparatus has been fitted up under the direction of Mr. C. Hortsek, who was specially sent out by Mr. Edison for the purpose. The engine and apparatus are placed in a large shed at the top of the gardens, and are connected with the House by means of an nsulated wire. The engine used is a ten-horse power one, and the generator is known as the Edison A dynamo-machine, calculated to produce current sufficient for 60 sixteen-candle lights. There was a large attendance of the public in the House last evening, and much satisfaction was expressed alike by members and spectators with the effect produced by the bright, soft, and penetrating light." We congratulate Mr. Hortsek on the success which has attended his labours.

UNDERGROUND TELEPHONE WIRES.—According to the *Operator* the American Bell Telephone Company have laid an underground telephone cable along the Boston and Providence Railroad, to ascertain the practicability of such cables for telephone purposes. Our contemporary says:—"The cable was made by Eugene F. Phillips, of Providence, R.I., and consists of 21 rubber-covered copper wires in an external protecting pipe of lead. Ten of these conducting wires, after being insulated with rubber, are covered with tinfoil, which is intended to act as a conducting surface to carry off extraneous induction currents. Ten more, after being covered with rubber, are twisted together, and are intended to be operated as metallic circuits. This plan is also regarded as a protection against induction. The twenty-first wire is an ordinary No. 13 office wire, covered with cotton and paraffined. The cable when completed weighed 30 tons, and filled three freight cars. It was laid on Sunday, April 16, between the two tracks of the Boston and Providence Railroad, the south end being at Attleboro, Mass., and the north end at West Mansfield. The entire length of the cable was about a hundred feet over five miles. It was divided into sections of 530 feet in length, each section coiled on a separate reel. A trench varying from eight to twelve inches in depth was made, in which the cable was buried, the two ends of each adjoining section being connected by screw connections in test boxes, placed at the required positions. Several lengths of the cable being uncompleted, the work of laying could not be finished until the following Sunday, April 23. The upper room at Attleboro Station is to be the testing room, and it is expected that valuable knowledge will be gained by the proposed experiments, which will be conducted by the electricians of the American Bell Telephone Company."

THE CITY AND ELECTRIC LIGHTING.—At a meeting of the City Commissioners of Sewers, on Tuesday last, when the subject of lighting the city was under consideration, Mr. Innes moved "That leave and license be given to electric lighting companies, who are lighting public ways, to light private property on the lines of their conductors." The cost of lighting by electricity would be very much reduced if the companies were allowed to supply houses along the line of their conductors. The committee had been seriously considering the vast expense which would be necessary in carrying out any system of electric light, and already one system had had to be abandoned on account of the very heavy expenditure. He thought he was betraying no secrets of the committee when he said that the contracts they had had before them showed that the electric lighting would involve an expenditure of over five or six times as much as the amount which was now incurred in lighting by gas. However, in most cases it was shown that the charge for the electric light itself was not so much, but that it was the charges incidental to initiating the system which were so very heavy. He considered that if any contracts were entered into at the end of the year a very considerable increase would have to be made in the rates of the City; and the committee viewed the amount of the expenditure in this particular with very considerable alarm.—Mr. Peebles seconded the motion, and spoke against the form in which the tenders for the electric light had been invited. He thought that it was only fair to the companies that a standard should have been laid down for the electricians to work to.—Mr. E. E. Ashby argued that the adoption of such a motion as the one proposed might lead to very great diffi-

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culties with the gas companies, on whom they had to fall back in case of accident. They must try before they entered into anything of that kind to arrange matters with the gas companies in an honourable and friendly manner. He thought the whole committee was in favour of electricity, but then it might turn out that, although it was a success as a light, it was too costly for general use. The committee did not desire to run up the rates in any way.—After some further discussion, Mr. Innes withdrew his motion.

Cost of Electric Lighting.—Mr. C. M'L. Hardy contributes a letter to *The Times* of 2nd June on the above subject, from which we extract the following:—"Electricity costs about one farthing per lamp of from 16 to 20 candle-power, as will be seen from the following. One horse-power will generate electricity to keep incandescent eight to 10 lamps, giving from 16 to 20 candle-power each. One horse-power consumes from 2½lb. to 3lb. of coal per hour. Two thousand lamps would, therefore, require from 4½cwt. to 7cwt. of coal per hour, which, at 15s. per ton, will amount to 3s. 4½d. or 5s. 3d. per hour, according as we take the more favourable or unfavourable expenditure. The cost for the installation and for the annual maintenance for 2,000 lamps of from 16 to 20 candle-power each will be approximately as follows:—

—	Installation.	Depreciation or cost of maintaining.	
Building	£200	at 3 per cent.	£6
200 H.-P. Engine	1,000	at 5 per cent.	50
Boilers & Furnace	500	at 7 per cent.	35
Dynamo Machines	1,000 to 2,000	at 2 per cent.	20 to 40
Leads and Fittings for 2,000 lamps, exclusive of lamps	1,500	at 2 per cent.	30
	£4,200 to £5,200		£141 to £181

Say £5,500 at £200 per annum.

Lamps lighted at dusk and extinguished at midnight will be burning 2,000 hours per annum and the annual cost will be as follows:—Interest at 5 per cent. £275, replacement, &c., £1,200, replacement of lamps £1,000, coal £500, engine-driver £100, stoker £50, electrician £150, rent of premises £100, sundries £125, total £2,500 per annum—that is to say, including 5 per cent. interest on the capital invested the cost per annum of 2,000 lamps giving from 16 to 20 candle-power will be £2,500, or 25s. per lamp per annum for 2,000 hours. Twenty-five shillings, or 300 pence, for 2,000 lamps for one hour is 30 pence for 200 lamps for one hour, or about 1d. per lamp for seven hours. Gas costs one farthing per lamp of six to eight candle-power per hour, as will be seen from the following:—1,000ft. gas, at 4s. 2d. equals 50d. per 1,000, or 1d. for 20ft.; 1,000ft. gas at 3s. 4d. equals 40d. per 1,000, or 1d. for 25ft. An ordinary burner consumes from 5ft. to 8ft. per hour, or at a cost of one farthing for a lamp of from six to eight candle-power. In considering the foregoing *data* the two following important facts should be borne in mind in favour of electricity:—First, in the cost for electricity the whole of the lamps, fittings, &c., are included, whereas with gas the consumers are supplied with the gas, but have to provide themselves with fittings, such as gas brackets, globes, &c.; second, the foregoing calculations are based on the assumption that the plant for generating the electricity cannot be utilised for quite six out of every twenty-four hours, whereas, by the adoption of secondary batteries (better known as accumulators, or storage batteries), by a comparatively trifling additional outlay, the same engines, boilers, dynamos, &c., may be utilised for about three to four times as many lamps, and so considerably reduce the cost."

Progress of Telegraphic Business.—The following extract from Mr. Preece's article on "The Age of Electricity," in *Time* for June, is interesting:—"The growth of telegraphic business in this country has been enormous, as is shown by the following figures: 1851—miles of wire, 7,303; number of stations, 198; number of messages, 48,490. 1862—miles of wire, 57,879; number of stations, 1,616; number of messages, 2,676,354. 1872—miles of wire, 87,719; number of stations, 5,179; number of messages, 15,500,000. 1881—miles of wire, 121,052; number of stations, 5,637; number of messages, 31,345,861. In 1852 it was mentioned, as an extraordinary fact, that 1,000 messages passed through the head telegraph office, in London, in one day. In 1872 the greatest number per day was 28,508, but in 1881 the number reached in one day was 60,471. The instruments fixed which, in the year 1869, when the Government took the telegraphs in hand, were 2,200, now exceed 13,000. The news which then reached only 144 towns is now supplied to 326 towns. The 173 newspapers that received this news have now increased to 525. While only six special wires were handed to these newspapers after business hours, there are now no less than 29 wires which are used solely by newspapers for their own purposes and their own advantages. The growth of business in the central telegraph station has been wonderful. No less than 14,300,000 messages passed through this office during the past year, of which 1,650,000 were local messages to the metropolis alone. There are in use at this office the following instruments:—140 single needles, 200 Morse inkers, 170 Morse sounders, 65 Wheatstone automatics, and 12 quadruplex. When the Electric Telegraph Company was first incorporated, in the year 1846, the rates to the public for the transmission of messages were a penny per word per mile for the first fifty miles, a halfpenny per word per mile for the next fifty miles, and a farthing per word per mile beyond one hundred miles. In March, 1850, this exorbitant tariff was so far reduced as to make 10s. the maximum charge, and in March, 1851, this was still further reduced to 8s. 6d. On the 17th November, 1851, the charge was again reduced to 2s. 6d. for 20 words within 100 miles, and 5s. for 20 words beyond that distance. Subsequently the charge was reduced to 1s. for 20 words within 100 miles, 1s. 6d. within 200 miles, 2s. within 300 miles, 3s. over 300 miles, and 4s. to Ireland. There was also a local rate of 6d. in some towns, but this was illusory, for the charge for porterage brought it to 1s. and over. Since, however, the telegraphs have been transferred to the State, an uniform charge of 1s. for twenty words has been made for the whole of the United Kingdom. Thus, a charge which was originally 4s. 2d. per word is now less than ¾d. per word, and there is a prospect of this rate being still further reduced to ½d. per word, with a minimum charge of 6d. In all these cases the addresses have been sent free, and this privilege has not only been very seriously abused, but it adds considerably to the cost of the transmission of messages, and offers an obstacle to the cheapening of telegraphy. As a peculiar instance of the result of a free address, the following was sent from Sherborne, and was delivered to 'Jim Pearce, a little boy in charge of a horse and gig, in a field called "Eight Acres," just above the railway station, Shepton Mallet, belonging to Mr. Giles, Farringdon Gurney.' If the public desire further cheapening in the transmission of their messages, they will, probably, have to forego the privilege of having their addresses sent free."

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THE PHENOMENA OF THE ELECTRIC DISCHARGE WITH 14,400 CHLORIDE OF SILVER CELLS.*

BY WARREN DE LA RUE, ESQ., F.R.S., SEC. R.I., ETC.

For the last six years I have, in conjunction with my friend Dr. Hugo Müller, been engaged with experiments on the electric discharge, using as the source of electricity a constant voltaic battery which we devised. It is in principle the same as that invented by Daniell, but in our battery a solid electrolyte, insoluble in water, or a weak saline solution—namely, chloride of silver, replaces the soluble sulphate of copper, so that no porous cell is needed in the chloride of silver battery. The results of our experiments my colleagues think of sufficient interest to be brought under the notice of the members of the Royal Institution, and I will endeavour to make them as clear as possible in the limited time at our disposal. I must, however, ask your kind indulgence if I fail, as I have not the practice of lecturing. It is true that it is not the first time that I have had the honour to occupy this chair, which I did upwards of forty years ago.

I may as well commence by describing the tool which I am about to use in the experiments. The diagrams will help you to understand it. The chloride of silver battery is made up as follows:—A glass tube $\frac{1}{8}$in. in diameter, $5\frac{1}{2}$in. long, and containing about 2 fluid ounces of liquid. Into this is fitted a paraffin stopper with two holes perforated through it; through one of these a zinc rod, 3-16in. diameter and $5\frac{1}{2}$in. long, is inserted, and fastened by melting a little of the paraffin around it; the other element is formed of a flattened silver wire, which passes between the stopper and the glass, so that the metallic elements are zinc and silver. On the flattened silver wire is cast the electrolyte—namely, a rod of chloride of silver $2\frac{1}{2}$in. long and 5-16in. diameter—and the cell is charged through the second perforation in the stopper with a solution of chloride of ammonium containing $2\frac{1}{2}$ per cent. of salt (Fig. 1). When the circuit is not closed—that is, when the silver element is not connected by means of a conductor to the zinc—no action whatever takes place; and in proof of this I may state that I have a battery which was made up more than six years ago, and is still in action, loss

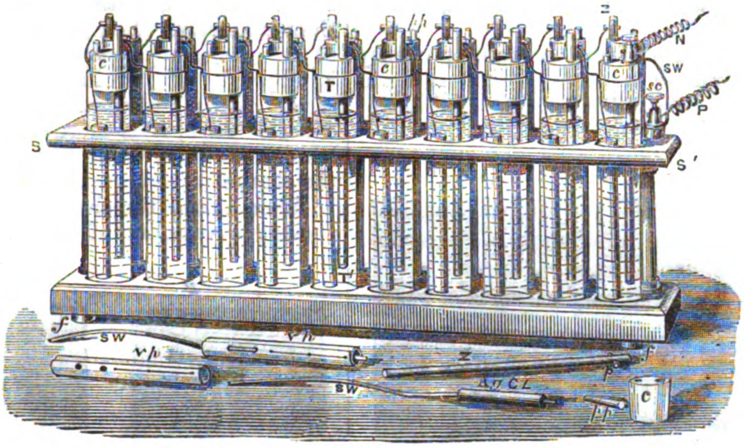

FIG. 1.

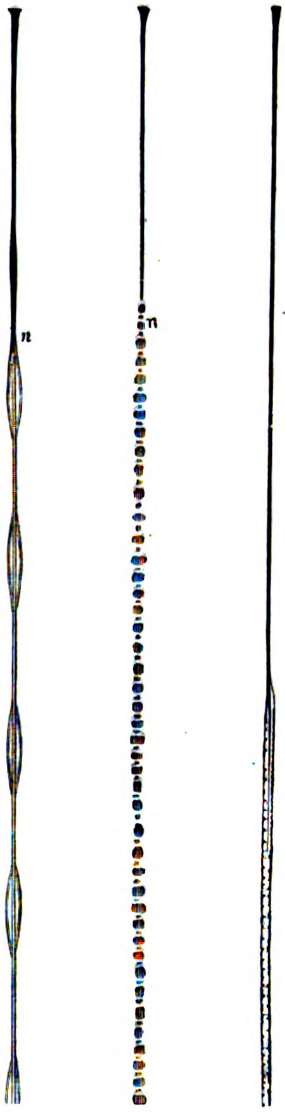

FIG. 3.

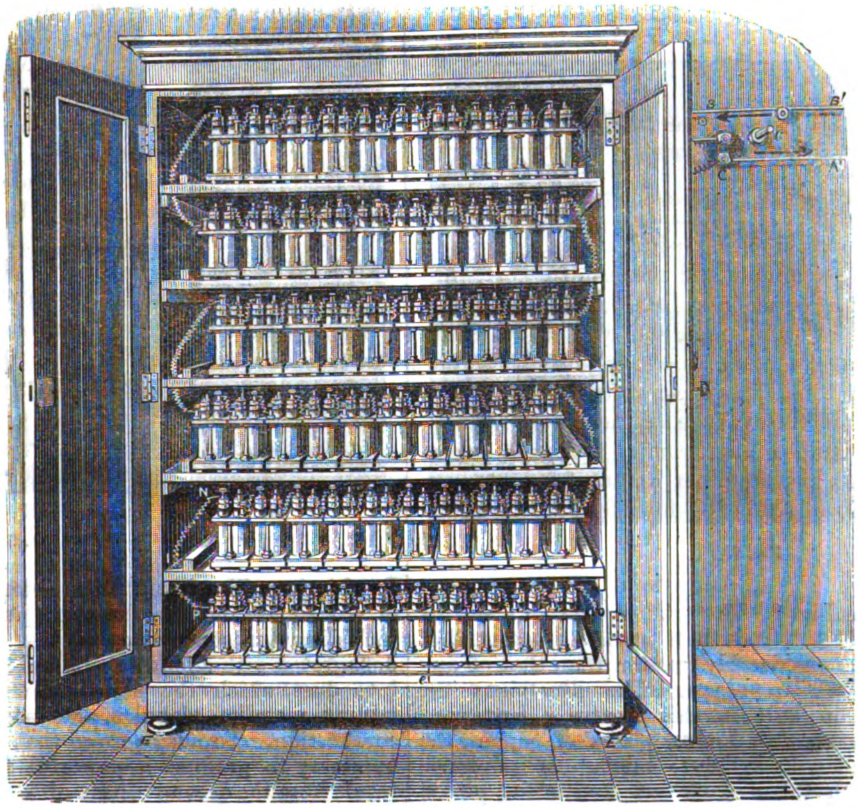

FIG. 2.

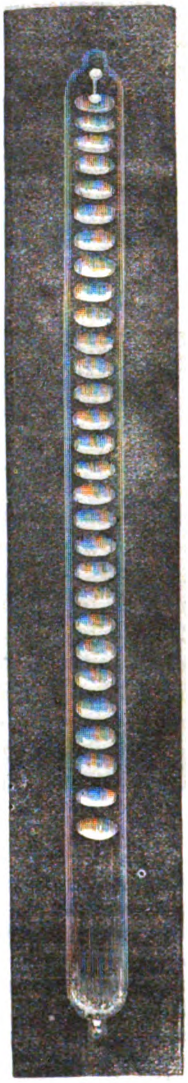

FIG. 4.

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of the fluid by evaporation having been from time to time made up. But as soon as connection is established, then the chloride of silver parts with its chlorine and the zinc dissolves, and metallic silver is separated, in a spongy state, from the chloride, and remains attached to the silver wire, retaining still the form of a rod. Such an element has the electromotive force of a volt (nearly 1·03 volt).

A volt is that electromotive force which, working through a resistance of one ohm, would deposit 0·0011363 gramme of silver from a salt of silver; or decompose 0·0000947 gramme (0·00146 grain) of water in one second.

A column of mercury at 0° Cent., one square millimetre in section, and 1·05 metre high, offers a resistance of 1 ohm; a pure copper wire, 1-16in. diameter and 129 yards long, offers a resistance of an ohm.

These cells are grouped together in trays containing twenty or more, and the trays are placed in cabinets containing in some instances 1,200 cells, in others 2,160 cells; a cabinet of 1,200 cells is shown in Fig. 2. The total number of elements I am about to use is 14,400, and these possess a potential of 14,832 volts, which is considerably greater than that of any battery hitherto united in series. The illustrious Sir Humphry Davy used in 1808, in this theatre, a battery of 2,000 plates, 4in. square, with double plates of copper, the battery being charged with a dilute mixture of sulphuric and nitric acids. With this magnificent instrument, placed at his disposal by the subscriptions of a few patrons of science, he obtained a spark 1-40th to 1-30th of an inch, when the terminals were made to approach each other (a striking distance of 1-40th of an inch would accord with our experiments with the chloride of silver battery, if the difference of potential of the two batteries is taken into account). When the discharge had once taken place then the terminals might be separated four inches without causing its discontinuance.

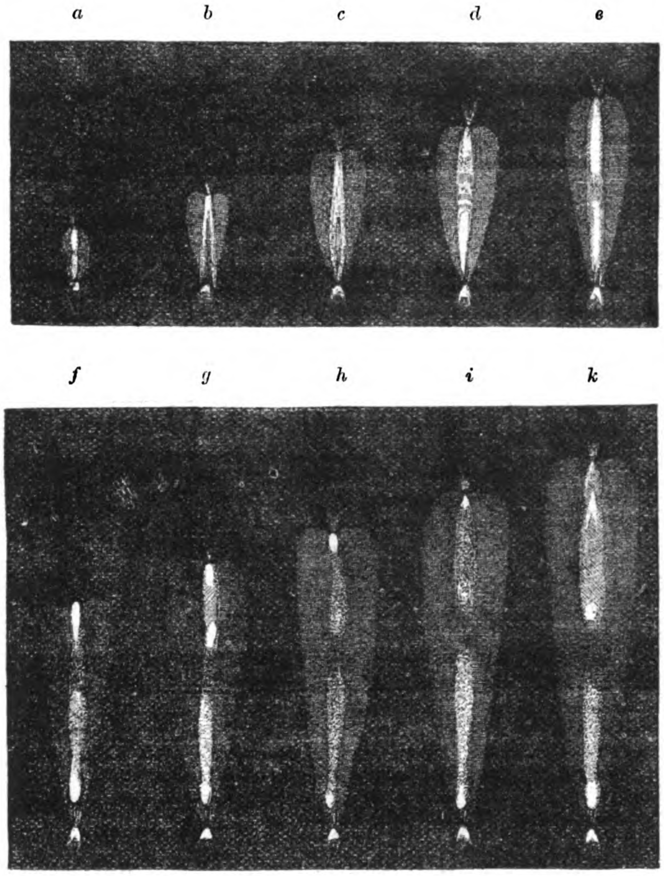

Fig. 5.

My friend, the late Mr. Gassiot, constructed several batteries of high potential, and at the time of his death there were 3,000 Leclanché cells in action at his laboratory. On January 26, 1875, I measured the length of the spark between points, and found it to be 0·025 inch; 3,000 of our cells produced a spark of more than twice this length, namely, 0·0564 inch, on account of its better insulation. I propose, in order to show the power we have at command, in the first instance to accumulate, by means of a condenser, the electricity from 3,240 cells, and to send its charge through a platinum wire 1-80th of an inch thick. In charging the condenser I will pass the current through a voltameter, in order that you may judge of the very small chemical force concerned in the production of the enormous mechanical effect of the electric discharge. I may as well at once tell you that the current necessary to charge the condenser I am employing would decompose merely 1-5,000th of a grain of water. I will first of all pass the current from twenty cells through the voltameter. You will see that there is a rapid evolution of mixed gases (oxygen and hydrogen) into which the water is resolved. The evolution of gas, you will at once perceive, is very much slower when the current is charging the condenser. Also, it is more rapid at first and then gradually lessens, and would entirely cease if there were no leakage of the charge.

When I send the charge of the condenser, which has the enormous capacity of 42·8 microfarads (or equal to 6,485

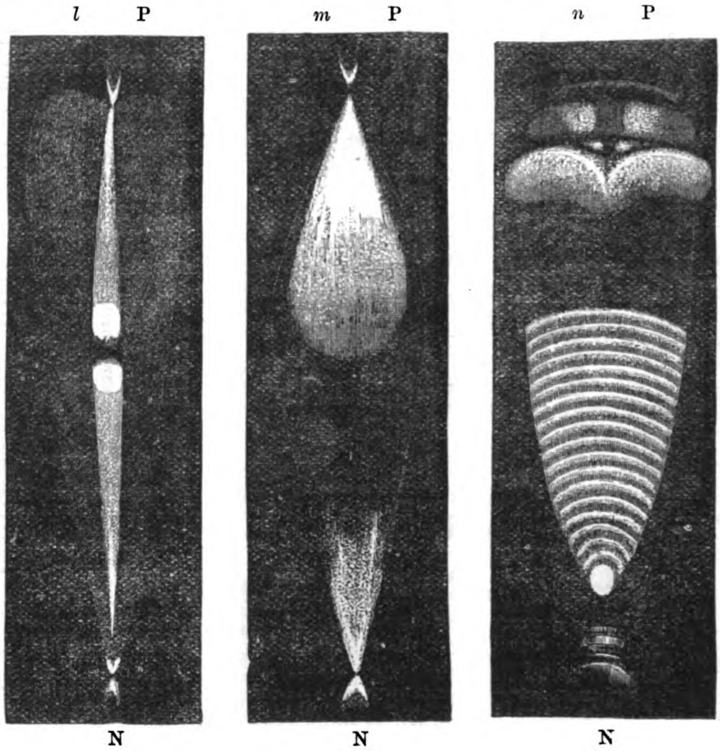

Fig. 5a.

Leyden jars, like that I have before me, which has coatings of 442 square inches), through $2\frac{1}{2}$in. of gold wire, 1-80th of inch diameter, strained on a glass plate, it will be violently deflagrated with a loud report, and the metal will be scattered into dust, which the microscope shows to be composed of minute metallic globules, and not an oxide resulting from combustion. Faraday proved that the quantity of electricity necessary to produce a powerful flash of lightning would result from the decomposition of a single grain of water. This can be realised when it is remembered that it would be 5,000 times as great as the charge of the 42·8 microfarads condenser just shown you. If we place the glass plate on which the wire was strained before the microscope, then it will be perceived that the distribution of particles of gold is not uniform along the space which the wire occupied, but on the contrary, they present a stratified appearance, indicating a series of pulsations during the apparently instantaneous discharge. I hope to show you shortly that the most steady discharge through a vacuum tube is in reality intermittent.

As I shall for this purpose cause the current passing through the tube to pass at the same time through an induc-

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tion coil so as to induce a secondary current, I will render evident to you in a striking manner that where electricity is caused to pass through a wire it induces another or secondary current in an adjacent wire. I have here two insulated wires, each 350 yards long, coiled side by side on a reel; to the extremities of one coil is attached a platinum wire six inches long and 1-500in. diameter; through the other coil I will send the charge of electricity from a condenser of seven microfarads capacity (about the sixth of that just used) charged with 10,800 cells. You perceive that the platinum wire is violently deflagrated with a loud report by the induced current.

The mechanical effects produced by the charge of a condenser are as the square of the number of cells used to charge it, and although the condenser which I have just used has only one-sixth of the capacity of that I first showed you, yet its mechanical effects are nearly twice as great; for the square of 10,800 is to the square of 3,240 as 11 to 1. In order to show the enormous power of its charge I will send it through 29 inches of platinum wire 1-100th of an inch in diameter; this is immediately deflagrated. And if I allow the charge to pass between the terminals of a discharger the loud report of the spark renders evident the enormous power stored up by the condenser. I had hoped to show you the condenser charged with 14,400 cells, but it is not capable of withstanding this potential, for one after the other of the coated glass plates of which it is made up has broken down with the charge shortly before the lecture.

In order to afford you an opportunity of forming a pictorial conception of that which it is wished to convey, respecting the stratified discharge, I will recall to your recollection an experiment often shown to you by Dr. Tyndall (Fig. 3). With a reservoir of water, placed at a height of a few feet, when the tap at the lower portion is turned on the water flows out, apparently in a continuous stream; but when the thread of water is examined by means of an intermittent beam of light, it is at once seen that the flow is not continuous, but (in consequence of the tendency of water to assume a globular form) the stream as it descends breaks up into a series of drops, one following the other in rapid succession. It is not my purpose here to refer to the cause of the phenomenon, which has been explained to you by Dr. Tyndall in his lectures on Sound, but only to recall this elegant experiment in order to present a mental picture of what may occur in the aggregation of the molecules of gases conveying electricity.

Now, I will cause a discharge of electricity to pass through a vacuum tube containing residual carbonic acid at a pressure of 0·5 millim. (Fig. 4), and you will at once perceive that the residual gas groups itself into a series of luminous strata, the molecules which composed them being held together by the balance of electric forces, where, as in the case of the water streams, the particles composing the globules are held together by cohesive attraction. The strata do not flow on like the drops of water, but remain stationary; they are, as it were, so many Leyden jars charged on one side with positive and the other with negative electricity; each imparts say its positive charge to the next negative end of the succeeding stratum, and receives a charge from that behind it; and thus the flow of electricity goes on from one terminal to the other without any movement of the strata necessarily taking place. If we examine the electric arc passing between the terminals of a battery, either at ordinary atmospheric pressure or at other less pressures, it is seen that there is a resemblance to the discharge in vacuum tubes, the light emitted by different parts of it not having the same intensity throughout, and that under most circumstances there is a tendency to break up into distinct entities of the nature of strata, and ultimately to take a stratified appearance like the discharge in vacuum tubes. From this we may infer that the discharge in a vacuum tube is, in reality, a magnified arc. I cannot show these phenomena in a way that you could make them out at the distance you are from me, but I will, with the assistance of Mr. Cottrell, exhibit to you copies of photographs of the arc in atmospheric air (a to n, Figs. 5 and 5A), taken in my laboratory under various conditions as to distance beween the terminals and pressure, as set forth in the table given in next column.

I can let you see the arc, although I am unable to show the details of its structure; thus, when I move the discharging key, the arc passes between the two points, 0·7 inch apart, fixed in the micrometer discharger (Fig. 6), in which, however, the terminals shown consist of a point and disc, instead of two points, which I am now using. And I may mention that before the discharge takes place there is neither con-

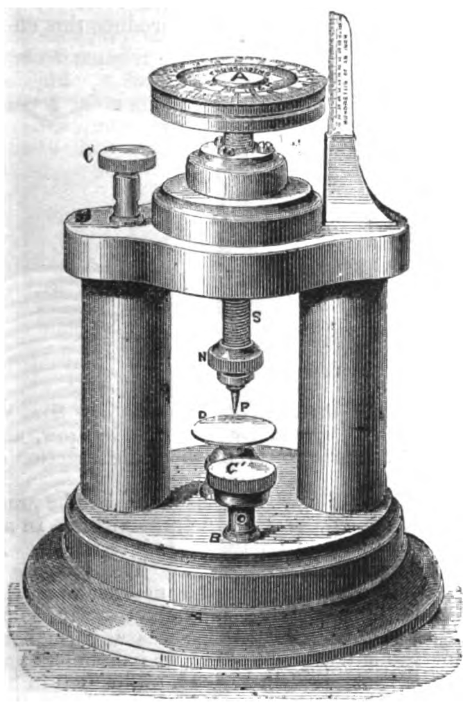

FIG. 6.

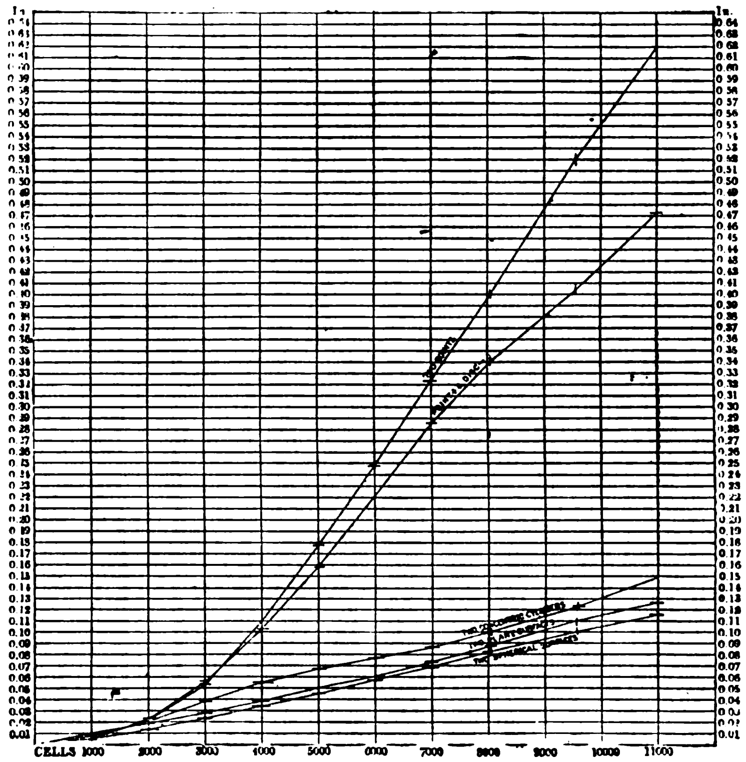

FIG. 7

densation nor dilatation of a gaseous medium in contiguity with the charged terminals, as has been suggested, whatever may be the form. The length of the arc varies with the potential of the battery and with the forms of the terminals; between points, the length of the striking distance increases as the square of the number of cells employed. Thus, with 11,000 cells it is 0·62in., as shown in the diagram (Fig. 7). The potential of 11,000 cells put our means of insulation to a severe test, and 14,400 cells overcomes it to such an extent as to interfere so seriously with the striking distance that I only obtain a spark 0·7 inch long.

Fig.	Distance.	Pressure.		Cells.	Current
	inch.	mm.	M.		Weber.
a	0·58	748·6	985,000	10,940	
b	× 2 ... 1·16	294·9	388,026	,,	0·02881
c	× 3 ... 1·74	191·3	251,711	,,	0·04060
d	× 4 ... 2·32	142·6	187,631	,,	0·04474
e	× 5 ... 2·90	112·6	148,157	,,	0·03459
f	× 6 ... 3·48	99·4	130,789	,,	0·03071
g	× 7 ... 4·06	85·9	113,026	,,	0·03259
h	× 8 ... 4·64	71·6	94,210	,,	0·02693
i	× 9 ... 5·22	65.5	86,184	,,	0·02693
k	×10 ... 5·80	64·4	84,737	,,	0·03071
l	× ... 6	67	88,158	11,000	too small to measure
m	× ... 6	8	10,526	11,000	0·01771
n	× ... 6·3	2	2,632	2,400	not measur'd

On the supposition that a cloud would act very much as a mere point at the great distance at which a lightning discharge occurs between clouds or a cloud and the earth, we may from these data calculate the potential necessary to produce a lightning flash a mile, or 63,360 inches long. It would require nearly 243 units of 14,400 cells united in series, or say 3,500,000 cells about.

The striking distance may be increased by an arrangement of condensers to form what is called a cascade, and in this way I shall be able to produce a spark an inch long with only 1,200 cells. Such a battery I now use to charge twenty-five plates of a small condenser, and by means of a rotating commutator, connect, so to speak, the outside of one plate to the inside of the next, and thus multiply the potential twenty-five times; 4,200 cells have, as you see, a very short striking distance; it is only 0·00608in., so that the spark obtained with the cascade is 164 times as long as with the battery alone. If there were no loss in converting quantity into potential, it would be 625 times or the square of 25. The apparatus I am using is the so-called Rheostat of Gaston-Planté. Franklin, it will be remembered, was the inventor of the cascade. It is not impossible that the effects of lighting may at times be increased by a kind of cascade arrangement formed by the charged layers of cloud floating one over the other.

(TO BE CONTINUED.)

THE TELEPHONE CASE.

(CONTINUED FROM PAGE 57.)

Sir W. THOMSON testified that the medium used in an Edison telephone for the purpose of varying the current must be semi-conducting, or such that, by varying the pressure between it and another substance, the resistance should vary, and hence the current inversely, also that it should be capable of itself, or by force of some arrangement, of recovering its normal position. It was not known in 1876, but is now known, through experiments of Sir W. Thomson, that carbon in one form may be equivalent to carbon in another form, both as regards initial conductivity and power of varying under pressure. The automatic action of the semi-conducting substance in great measure depends upon the position in which the carbonaceous particles are put in the circuit. In his cross-examination by Mr. Hemming the following questions and answers were given :—

"Mr. HEMMING: What was it Bell invented or discovered with reference to the iron disc which you say was such an important discovery as to deserve a patent?—A. That disc, that simple round iron disc, clamped with wood, now mechanically clamped round the edge in the neighbourhood of a magnetic pole, was capable of producing all the motions of the air required for articulate speech. I may say it is a most surprising discovery that after what I had seen with that Glasgow instrument, after what I had heard at Philadelphia, I was exceedingly surprised when, many months afterwards, I was first presented with the modern Bell receiver. At Philadelphia and in Glasgow I would not have thought it possible that that instrument could produce this result; and I am perfectly sure I speak the unanimous feeling of everyone who knows anything of electricity in the world when I say that if that ordinary Bell receiver was put into the hands of any living person, and he was asked 'could that produce the effect?' he would have said, 'I do not believe it possible—it is a mere chimera.'

. . . .

"Mr. HEMMING: I understand you rightly, I think. You say, even after this publication of the 11th of August, 1876, which described the old instrument of Bell, it was unknown that it was possible to get the same action out of iron?—A. It was supposed that a powerful electro-magnet was necessary, and the only way shown of obtaining that powerful electro-magnet was by a current in the line wire, which might have to be a very powerful magnet. Some Bunsen cells—I never knew how many—were used by Bell at Philadelphia, and I myself all the time was under the impression that it was a kind of effect that would require very powerful appliances, and to find afterwards the very simple appliance in that well-known Bell receiver, that little bit of steel with the magnetism, would produce this effect is a tremendous discovery."

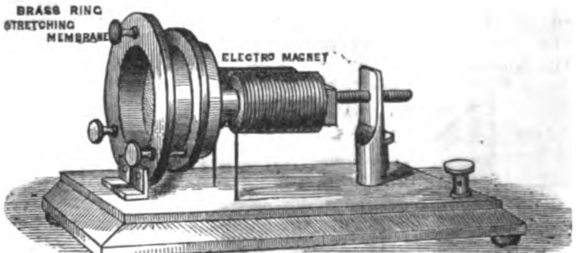

FIG. 9.—Glasgow Transmitter.

Figs. 9 and 10 show the instruments brought by Sir W. Thomson from America, and shown by him at Glasgow, and mentioned by him in his address to the mathematical section of the British Association.

The Hunnings transmitter Sir W. Thomson held to be practically the some instrument as the Edison transmitter. In all practical and theoretical respects it is the same instrument. It is obviously intended for the same purpose. The purpose is obviously attained by operating in a similar manner upon the same properties of material. There is substantially some difference of detail. As to the receiver there was a permanent magnet in the Bell instrument. The Cox-Walker instrument had an electro-magnet. It is illustrated in Fig. 11. But Bell in his specification describes electro-magnets as being interchangeable with steel magnets. The Cox-Walker instrument was not adapted to work merely by local circuit; there must be a current through the line wire. Bell's instrument could work with an alternating current.

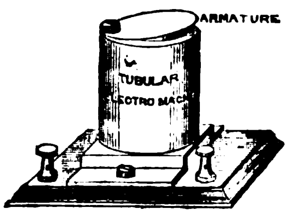

FIG. 10.—Glasgow Receiver.

In Fig. 12 we illustrate Hunnings's instrument, which the plaintiffs assert is an infringement. This instrument was patented by Mr. Hunnings, who is a clergyman, on the 16th of September, 1878, about fourteen months after the date of Edison's patent. Mr. Hunnings states that his apparatus consists of one or two vibrating diaphragms, composed wholly or in part of suitable metal, such as, preferably, platinum, silver, ferrotype iron, tinned iron, &c., placed in close proximity to each other, and connected respectively with the opposite poles of a galvanic battery. The receiving telephone being in circuit, the

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intervening space is filled with carbon or other suitable conducting substance—preferably in the form of powder—and about $\frac{1}{16}$in. in depth. The whole is secured in a box of suitable non-conducting material with a mouthpiece. The great feature claimed by Mr. Hunnings is the use of carbon in a state of fine loose powder, not in any way compressed or consolidated. Mr. Hunnings does not claim the principle of using carbon in the solid or consolidated form to increase or diminish the resistance of a telephonic current for the purpose of transmitting sounds, as this is well exemplified in the well-known Hughes microphone and the Edison carbon telephone; but he does claim the use of finely powdered carbon in the loose or free state as a means of varying the resistance of a telephonic circuit by the vibrations of a thin metallic diaphragm enclosing it, controlled by the sound waves impinging on it. Thus it will be seen that the point made by the defendants is that they used powdered carbon, by preference engine coke crushed but not ground fine, whereas Edison uses carbon in a consolidated form. We have already given the claims of the Bell patent, and those made by Edison. It will be well, however, to again point out that they are said to cover the use of a diaphragm in a telephone, the eleventh claim running:—"The combination with an electro-magnet of a plate of iron or steel, or other material capable of inductive action, which can be thrown into vibration by the movement of surrounding air, or by the attraction of a magnet." It is, of course, alleged by the plaintiffs that such a plate is found in the Cox-Walker receiver.

Dr. JOHN HOPKINSON deposed that in Bell's patent there are two several novelties. One of those is the substitution of a plate diaphragm, carried in a way described in the drawings of the specification, in lieu of a diaphragm of metal, such as of a membranous character. The second invention is the use of a permanent magnet in a telephone, instead of an electro magnet excited by a battery in the single circuit of the line wire, or instead of that permanent magnet its obvious equivalent, an electro magnet excited by a battery which has nothing to do with the line wire.

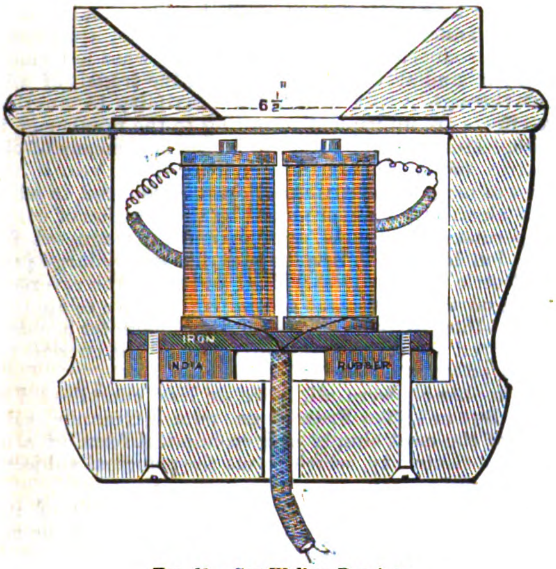

FIG. 11.—Cox-Walker Receiver.

It was stated by this witness that the resistance of the coil of the instrument shown by Sir W. Thomson to the British Association at Glasgow is 1,450 ohms.

Mr. JOHN IMRAY stated that he had successfully made a pair of instruments from Morgan Brown's (Bell's) specification.

Mr. EDWARD STEBBINS JOHNSON said that Edison in 1876 began to work at the telephone as now known, but that he has for some years been experimenting in acoustic telegraphy. Mr. Johnson stated that the Edison instrument with plumbago on silk worked well, in fact with plumbago in any shape put into it, and that he had tried every form of tension-regulator described in the specification.

The examination of the plaintiffs' witnesses ended and that of the defendants' commenced with

Mr. HERBERT JOHN ALLISON, who testified as to the publicity of specifications and pamphlets at the Patent Office library.

Rev. HENRY HUNNINGS stated that he commenced experiments with the telephone immediately after the British Association meeting at Plymouth, 1877, and in November of that year he made a transmitter, consisting of a mouth-piece, an iron plate, a piece of platinum slightly dented, then a screw carefully turned in the lathe to fit into this dent, and so adjusted it backwards and forwards to try and make it speak. He tried an instrument on a special line between the Archbishop of York's Palace and the vicarage either at the end of November or the beginning of December, 1877, but it did not answer well. About April, 1878, a peculiar transmitter was tried, which consisted of a lidless box about two feet long, with a piece of paper glued on. An electrode was applied at one end, also at the other with a line of cinders from the grate. On speaking to the line of cinders the reply came back, "Yes, I hear." Then a piece of engine coke was found, and ground up into particles, which were placed between two pieces of paper. The witness said, "I turned a wooden ring in my lathe between two inches in diameter and ⅜in. thick. Of course, I must have something on each side of this ring to hold the grains of coke, or otherwise they would tumble through, so I placed paper with a piece of tin foil in it, and another paper the other end with tinfoil, and stick those things in three screws." . . . I found that to answer very well, so I went on until the instrument took the form it is now in." The witness, asked to state what he considered the distinction of principle in Edison's transmitter from his own, said: "All through Edison's specification I find that he works upon the pressure system. My principle is the loose points of contact, and the reason that I made use of this oven-made engine coke . . . . was because, taken bulk by bulk, its specific gravity is the lightest thing I can find, so that sound waves can move about these particles very easily." The witness also stated that "if you pack up grains of coke together tightly the instrument will not answer, it (the coke) must be in a perfectly loose condition, so that you can hear the grains shake about."

Mr. THOMAS AUGUSTUS WATSON, the maker of Bell's instruments shown at Philadelphia in 1876, and of those brought to England by Sir W. Thomson, stated that when he saw the finished instrument "the diaphragm laid flat on the top of the box."

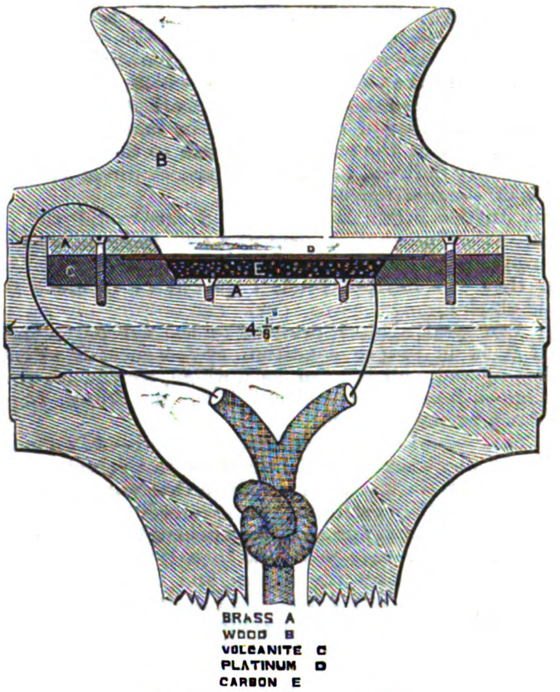

FIG. 12.—Hunnings' Transmitter.

Professor SILVANUS PHILLIPS THOMPSON showed that the Glasgow receiver would act by arranging it to act in the hands of Mr. Justice Fry, and suggested the failure at Glasgow to have been caused by a bad transmitter or bad connections. Asked to explain the difference between a tuning fork and a tympan, he said: "A tuning fork has two prongs, which, when it vibrates, approach to one another like a couple of doors opening or shutting on their hinges, with this difference, that there is no hinge, and, therefore, the metal must bend. That is what a tuning fork is intended for, and it is made perfectly stiff and thick that it should only vibrate in that manner, the two prongs waving to and fro as a whole. If it were thin it would vibrate in a nodal manner with nodes superposed on it, as a reed does in the case of a harmonium. They vibrate like tuning forks, except they break up into ripples; they are not tympans, but reeds. But a tympan, when it vibrates, vibrates in its fundamental node as a whole, or also with ripples; but there is this distinction, the fundamental node being that the tympan bulges in and out alternately on the upper and lower surface. But, besides that fundamental node, there are higher nodes corresponding with

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the high nodes of vibration of a tuning fork or a reed. If you impose on a tympan a higher node of vibration, no matter whether it has a central attachment or is perfectly free all over the surface, these high nodes will consist in there being ripples, concentric ripples, round the centre. The whole surface is thrown into concentric circles, like those you see in a pond when anything is thrown in, and every portion of the tympan in concentric circles is rippling up and down with circles, nodal lines all round; so there is this perfectly well marked distinction between tympanic vibration and the vibration of the tuning fork. In one case you have ripples in circles, in the other case in straight lines."

Professor Silvanus Thompson's evidence concerning the Hunnings and Edison transmitters may be given in full. Thus:—

Q. And you have worked with an Edison transmitter and with a Hunnings transmitter?—A. I have.

Q. Having those two instruments in your hand, will you say whether there are any differences in principle between the mode in which they work, and if there are any, what you consider those differences?—A. The differences are very striking. In the first place, there is in the Edison transmitter this mechanical arrangement, this mechanism for collecting the sound waves from the air, and transmitting them mechanically through this arrangement to the mass below, which is under artificial compression by means of a screw below it.

Mr. Justice FRY: That is, you mean there is a diaphragm, a tympan, and a cork?—A. Yes. In the other we have no tympan or cork to press artificially downwards, no screw to make that pressure upwards. We have, or rather we should have, if this were in good condition, a lot of loose grains of coke under the platinum electrode, and resting on a solid table of brass.

Mr. PEARSON: Those are the differences in the construction. Now, in the principle of working, what is the difference in the principle of working in the two instruments?—A. It is this, that the vibrations of the air are collected by this mechanism, and impressed upon the mass underneath, the mass already under elastic compression, and its resistance is thereby caused to vary. In this other case we have a thin, comparatively loose piece of platinum foil—the electrode, in fact, which, when you talk to it, shakes, and shakes the carbon underneath it, producing a larger or smaller number of contacts, and in that way the resistance to the passage of the current is varied, so the action in one case is physically indirect, in the other case as direct as the arrangements of the instruments admitted.

Mr. Justice FRY: In the second case would the electrodes vibrate as a tympan?—A. Not as a true tympan, because it cannot ripple in circuits as the true tympan can.

Q. How will it ripple?—A. I question very much whether it would ripple.

Q. You speak about it pressing on the carbon underneath?—A. If it is in proper condition of looseness it will simply be pushed up and pulled down, as a whole, by the air-waves that impinge on it as the little electrode in the Edison is pushed up and down by the pressure.

Q. That would be the resultant of waves?—A. Of waves themselves, in any case. All the air does in a sound wave, a plane wave, is that the particles of air in that wave move backwards and forwards, they oscillate, and then oscillate this piece of foil and make more or fewer contacts against the loose coke underneath. In either case you talk to a tympan; that is to say, a drumhead which is set into ripples, and those ripples have nodal lines in circles all round, and the resultant of those, with more or less imperfection, as represented by the movement up and down at the central point. I draw a complete distinction between the motion you have in the tympan itself and in the platinum electrode at the bottom.

Q. Supposing the same sound is uttered to an Edison transmitter and to a Hunnings transmitter, will the up and down motion result in the cork of the one and in the platinum foil of the other?—A. Very nearly, but in the case of the Hunnings that would be more true to the real vibrations of the sound than in the case of the Edison.

Q. There would be a certain amount of disturbance in the transmission?—A. Yes, the mechanism necessarily implies that you loose something.

Q. But, subject to that loss, the up and down motion to which you speak, the same utterance of sound is the same with the cork in one and the platinum in the other?—A. The two electrodes move up and down absolutely identically, subject to the necessary imperfections on account of the mechanism of the cork.

Q. I suppose those principles which lead to those similar results were familar to persons familiar with acoustics?—A. I am not quite clear how much we knew at that date. It was known that a tympan when it vibrated rippled in circles; it was known that the central point would represent more or less accurately the resultant of the motions imparted to the tympan; and it was also known, what Sir William Thomson explained when he was in this place, that a limp, a perfectly limp sheet, acted upon by the waves of the air, would follow every wave of the air without being thrown into ripples upon its surface. But I think I am justified in saying that in the case of the Hunnings transmitter we realise the direct action as nearly as we can, whereas in the Edison transmitter we have this mechanism, which first takes these waves which move up and down, and causes them to set this tympan rippling, and then takes the resultant or, as far as can be, the resultant of those ripples as a central point, and pumps that into the electrode.

Q. In the Hunnings you get the up and down motion from the voice direct on to the particles?—A. Yes.

Q. In the other case you translate it into nodal waves, retranslate the nodal waves into an up and down motion?—A. Your lordship has expressed it precisely.

Mr. PEARSON: May I take it that you do not consider platinum foil, the electrode in Hunnings's instrument, the same thing as the tympan in Edison's instrument?—A. No, because it acts in entirely a different way, it corresponds to the platinum electrode in Edison's.

Q. Inside the case in Edison's, the one I put into your hand, you have plumbago fine?—A. Yes.

(TO BE CONTINUED.)

ON THE GRAMME DYNAMO MACHINE AND THE ELECTRIC LAMPS EXHIBITED BY THE BRITISH ELECTRIC LIGHT COMPANY.*

BY EDWARD B. BRIGHT, C.E.

About half a century ago the connection between electricity and magnetism was discovered, and that if a current of electricity was passed through a wire parallel and adjacent to a magnet suspended on an axis, the magnet would be deflected to the right or left according to its polarity and the direction of the current.

In like manner if a magnet is moved across a wire an electric current is produced in the wire. This is what is termed induction, and a similar effect results from the transit of an electric current through a wire placed in proximity to another wire. These effects are multiplied according to the number of turns of the wire. Motion being found to be the best means of obtaining an electric current, there had been, prior to the year 1870, several varieties of magneto-electric machines introduced in which currents of electricity were produced by the rotation of coils of wire before permanent magnets, or of permanent magnets before coils of wire; but in these it may be said that a very large proportion of the electric power was sacrificed owing to the reverse current occurring on the movement of one coil of wire to another being lost. In other early machines of this character a commutator was employed to reverse the direction of the current for each change of polarity.

These appliances were all, more or less, complicated and defective. But in 1870 a Frenchman, named Gramme, solved the question of the most simple and economical form of a machine to produce electricity, which forms the principal subject matter of my lecture.

Mr. Gramme has been a remarkable instance of inventive capacity. Being employed on the repair of one of the magneto-electric (or so-called "Alliance") machines in France, he perceived that the true principle of producing an electric current had not been then practically applied; and with rare mechanical skill and an insight into electrical principles that amounted almost to intuition, he, with indefatigable zeal, succeeded in producing a dynamo-electric machine which was the first to yield an uniformly continuous current and without reversals by commutators.

After explaining a diagram of the Gramme machine, the lecturer said:—

It will be understood from this that the position of the poles is fixed though the ring rotates, giving off a constant stream of electricity in doing so.

I should here mention that in 1861 Signor Pacinotti, of Pisa, devised a machine somewhat resembling that of Mr. Gramme, but intended to convert electricity into motive force, and had Signor Pacinotti realised the value of the principle involved, and adapted his apparatus to the production of the electric current, we should now be ten years further advanced in the development of electric lighting.

Various modifications of Mr. Gramme's dynamo-machine have been made and brought forward as so-called improvements, some of which are shown in this Exhibition, but experience indicates that, whenever the simplicity of Mr. Gramme's invention

* Lecture at the Crystal Palace.

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is departed from, a reduction of effect results compared with the power employed.

The experiments made by the Commission of H.M. Royal Engineers at Chatham in 1879-80 gave the following comparative results from the same horse-power:

	Luminuous Intensity.
Gramme Machines (average)	1,928
Siemens ,, ,,	1,428
Wylde ,, ,,	877

The experiments of the Committee of the Franklin Institute, United States, gave the following figures of merit:

Gramme Machine	(useful result)	38
Brush ,, (large type) ...	,,	·31
,, ,, (small type) ...	,,	27
Wallace Farmer Machines (average)	,,	13

The efficiency of any dynamo-machine for any particular class of work depends largely upon the proper proportioning of the masses of iron and the resistances of the wire in different parts of the machine.

It is owing to the fact that Mr. Gramme and others have unceasingly experimented on this subject, and also that more Gramme machines have been constructed than all the other types put together, that the remarkable efficiency of the latest forms on the Gramme principle has been attained.

Electric lighting is, of course, no novelty. In the old days, before the invention of these machines for producing electricity in quantity and economically, many inventors occupied themselves in devising electric lamps. Among the most earnest of these was Mr. Staite, who some of you may remember about thirty years ago exhibited a light from the top of the column in Trafalgar-square; and to whom I happen to have been a coadjutor in important electric lighting experiments in 1853, when the Liverpool landing stage and that part of the Mersey were illuminated by an arc lamp, the electricity for which was derived from a powerful series of galvanic batteries, which I need not tell you were neither suitable nor economical for commercial purposes.

Arc Lamps.

The various forms of arc lamps have all until recently had the relative position of their carbons regulated by the current transmitted, and in practice when this is done the adjustment comes into play a little too late and continues a little too long, giving rise to the frequent and considerable variations in light noticeable in this class of lamps. In a lamp invented by Mr. Brockie, and which forms one of the exhibits of the British Electric Light Company, the regulation is mechanical and periodical, and not in any way dependent upon any irregularity of current or in the consumption of the carbons.

Although the small incandescent lamps are so much more pleasant and steady in their light, and are undoubtedly more suitable for domestic purposes, the arc lamp possesses considerable advantages for many purposes, such as lighthouses, lighting large spaces, &c. The Brockie lamps have been in use for a long time at Cannon Street and other railway stations.

Incandescent Lamps.

Electric lamps for giving light by the transmission of the current through carbon in a vacuum were devised nearly forty years ago, but it is only during the last two years that they have been introduced in a practical shape.

The first desideratum in such lamps is a perfect vacuum, and the next an uniform conductor inside. The conducting filament, as a rule, is made from some vegetable fibre, which is carbonised by various processes. Strips of parchment, bamboo shreds, Turkey grass, and cotton thread have been employed by various inventors.

In the example I show you *bass* is the material, from the inner lining of the bark of certain trees. There have been many doubts expressed about the duration of such lamps, but this lamp is one among many of which a careful record has been kept. It has been used at one of our clubs for many months, and has been lighted for 1,860 hours.

If the particles forming the carbon filament of an incandescent lamp are homogeneous—that is, if the substance is pure, the density uniform, and the atoms evenly distributed—then the electrical motion transmitted does not produce irregular vibrations that would tend to disintegrate the filament. In such cases I see, theoretically, no limit to the endurance of the internal conductor provided the vacuum is perfect and excessive currents are not passed through such as would raise the temperature to the point of vaporising the carbon. Lamps of this class are now made to give even 500 candle-power.

Electric lamps have been worked from a Gramme with a length of over four miles of wire from the dynamo machine. It is obvious from this that one distributing centre would, if necessary, cover the supply to the greatest part of London, and that one distributing centre would suffice for every other city or town in the kingdom. As an instance of practical application the British Electric Light Company lighted up the Yacht Club and the Scottish Club with incandescent lights nearly a year ago, the distance being about ⅓ mile, and other incandescent lighting has since been added from the same centre.

On the subject of cost and convenience, as compared with the employment of gas, I may mention that the space required for an electric light generating station would not be one-twentieth of that needed for gas works, light for light, and that the conducting wires would cost very much less than the gas pipes, while the soil of the streets would not be contaminated, and there would be no risks of explosion either in the buildings or streets.

I now come to the use of Gramme machines for the transmission of force. In many cases where steam or other engines cannot conveniently be used on premises, a Gramme machine can be utilised to turn sewing machines or other apparatus by having a wire in connection with some central station where dynamo machines are driven to produce the current. For instance, at the British Electric Light Company's premises in Heddon-street the blast for a number of blow-pipes is required at the top of of the building in the rooms where the incandescent lamps are made, and the bellows are worked by a small Gramme machine on that floor, which is connected by a wire to a Gramme driven on the basement by the engine, thus obviating the difficulty of working the bellows by means of a long belt or other gearing through the intermediate floors.

In the south of England, where a district formerly arable but now mostly pasture land is intersected by a number of streams with many disused water mills, arrangements are being made for a railway of over thirty miles long, to be worked by means of electricity generated by Gramme machines driven by the otherwise waste water power.

PHYSICAL SOCIETY.—May 20.

Professor Fuller in the chair.

Professor W. Chandler Roberts, F.R.S., communicated the results he had obtained in repeating the experiments of M. W. Spring, Professor of the University of Liege, on the union of finely divided particles of metal by pressure. M. Spring had shown that at a pressure varying from 5,000 to 7,500 atmospheres, metallic filings may be united into coherent discs. Thus, at a pressure of 6,000 atmospheres, bismuth filings may be united into a disc, which has a crystalline fracture and a density which is identical with that of the metal cooled from the molten state. Zinc, again, also a very crystalline metal, will weld into a disc at a pressure of 7,000 atmospheres, and the metal will even "flow" into cracks between the die and the collar surrounding it, just as in the experiments of M. Fresca lead "flowed" under similar circumstances.

Professor Roberts had repeated and confirmed many of the experiments of M. Spring, whose more recent results are of special interest, as he has shown that if filings of bismuth, lead, and cadmium be *mixed* in suitable proportions, such, for instance, as in Wood's alloy, and if the mixture be submitted to a pressure of 7,500 atmospheres, an *alloy* is obtained which will actually fuse at 70 deg. C., the true fusing point of Wood's alloy being 632 deg. C. Professor Roberts showed to the society an alloy he had prepared which melted below 100 deg. C., although of the constituent metals the lowest melting point is 230 deg. C., and he pointed out the great interest both to the physicist and metallurgist of M. Spring's results.

Mr. Lecky gave the results of tests of Mr. Bennet's cell (described at the last meeting) made by Professor Guthrie. The electromotive force was 1·14 volt, the internal resistance 0·8 ohm, but both quantities vary under certain conditions.

Professor Macleod also gave the results of tests made by him. These show that the cell rose in E.M.F. from 1·005 volt on charging to 1·213 volt after standing three days. The internal resistance was then 1·007 ohm.

Mr. C. V. Boys then exhibited an improved form of his vibratory meter for measuring electric currents, and specially designed for electric lighting purposes. He has applied to the form formerly shown to the society the contact-making device employed in Hipp's electric clocks, which, though imperfectly adaptable to the clocks, is perfectly adaptable to the meter. The force is proportional to the displacement. No sliding contacts are employed. Mr. Boys also explained some other plans for current meters, one of which he believes to be the final form for practice, and which, besides being remarkably simple in construction, is free from the objection of being tampered with by means of extraneous magnets. In reply to Professor Foster, he stated that self-induction does not disturb their action.

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THE ELECTRICIAN.

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All communications to be addressed to 396, Strand, London, W.C.

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ELECTRIC LIGHTING BILLS.

The promptitude with which the parliamentary committee on electric lighting Bills have arrived at their decisions and issued their preliminary report augurs well for the prospects of the new light. Notwithstanding the strong and combined opposition of the gas companies, the committee give expression to opinions which practically disregard such opposition altogether. The promoters of electric lighting enterprise may be congratulated on the times being favourable to their schemes. Vested interests of every description are at this moment in bad odour; and especially is this the case with respect to the two great corporations which have long possessed the monopoly of supplying us with water and with gas. The report of the parliamentary committee, as well as the Bill introduced by the President of the Board of Trade, are undoubtedly coloured by this prevailing sentiment, though neither can be accused of intentional unfairness or injustice. It is in their changed attitude towards the sacred rights of monopolies, rather than in any disposition to confiscate those rights, noticeable in the proposed legislation, that we find assurance of a fair field for the electric light. If it obtain none of the favour conferred upon similar undertakings of the past, it will at least escape some of the hindrances which competitors hitherto have had to confront.

On the whole, the resolutions of the select committee are fairly satisfactory, although in one or two respects they are not likely to go unchallenged by both the parties interested. The Board of Trade, it is suggested, should have two classes of powers for granting leave to electric lighting undertakings—the one when the consent of the local authorities is forthcoming, the other when it is not. In the first case the license may be granted by the Board itself for a term of five years, renewable at the end of that period; in the second case parliamentary authority must be obtained—presumably to override the objection of the local authorities. No limit is named for the operation of the provisional order obtained through Parliament, but as purchasing powers are granted at the expiration of fifteen years, that, presumably, is the period contemplated as the consequence of a victory over the local authorities where they oppose the scheme.

Various resolutions deal with the powers conferred for the breaking up of streets, the keeping of separate accounts where the light is supplied by local authorities, and with the control over the wires. It is satisfactory to observe that overhead wires are forbidden except with the consent of the local bodies; but in the event of their consenting to or themselves erecting overhead wires proved to be dangerous, or "likely to become dangerous to the public safety," an order directing their removal may be obtained from two justices of the peace. As a nominal warning that danger may be incurred, this provision counts for something—but not for much. The difficulty of proving the actual or possible danger of that which in the first instance has been thought perfectly safe is obvious; and to suppose that private individuals are ever likely to raise the question against public corporations is contradicted by all our experience. Wires of this kind are either dangerous or they are not, and it would have been better to have expressed a decided opinion one way or the other. Resolution 12, however, which deals with this matter, may prove salutory, not, perhaps, so much because of its penal as of its premonitory character. The erectors of overhead wires cannot say that they have not been warned.

The resolutions relating to purchasing powers and to the gradual extinction of gas interests will provoke the chief opposition. They are numbered respectively 8 and 10; and it cannot be denied that the provisions here set forth are open to a good deal of criticism from whichever point of view they are regarded. Both are impolitic, for the one will unnecessarily exasperate the gas interests, and the other will not encourage electric enterprise. Number 8 reads as follows: "That where it has been proved . . . . that any area . . . . is sufficiently supplied with electric light, and that the supply of gas in such area *has ceased* (the italics are ours) *to be remunerative*, the Board of Trade be empowered to make an order relieving, either wholly or in part, any gas authority from being compelled to supply gas within such area." Nothing but extreme haste will excuse such an extraordinary proposition as this. It cannot be seriously supposed that any gas company will allow itself to be slowly superseded, and to continue a lingering existence until it "ceases to be remunerative," in order that the Board of Trade may formally give it leave to die. It is not our province to supply the gas companies with arguments; and indeed on this point they have no need of our assistance. They must be prepared to face fair competition; but to press upon them an obligation such as that set forth in Resolution 8 is to provoke them into assuming an attitude which might result in there being no competition whatever. The monopoly of the gas companies is coupled with obligations; and to enforce these obligations to the last expiring gasp while deliberately invading the monopoly is simply impossible. To attempt it is to provoke defeat, and we are persuaded that the promoters of electric lighting have not knowingly countenanced

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this proposition. They are prepared to enter competition on equal terms; but they are well aware that to seek for terms unduly favourable to themselves would be the surest way of getting no terms at all.

On the other hand, Resolution 10, dealing with the conditions of purchasing private electric lighting undertakings after fifteen years—as set forth in Resolution 9—is of doubtful fairness to the promoters. The value of the land, buildings, works, plant, and so forth, is to be taken into account when the local authorities choose to exercise their compulsory powers of purchase "at the end of fifteen years, or at the end of any subsequent period of five years," but—and here comes in the hostile sentiment to which we referred at the outset—"without any addition in respect of compulsory purchase, or of goodwill, or of any past or future profits, or of any similar consideration." The shadow of Mr. Cross's Water Bill is evidently over this resolution; we are going be very farseeing, very virtuous, and very clever in all future concessions—at least, so thinks the President of the Board of Trade. But it is possible to be over clever, and we think this is an instance of the kind. For thrice five years only are the proprietors of electric lighting to reap the fruits of their enterprise; at the expiration of that term their stock in trade may be bought at a valuation, and their trade itself appropriated. The one sole merit of this form of prospective confiscation is that it gives at least a fifteen years' notice. The drawback is, that we have no experience of how it will work; but we can make a good guess. It will increase the price of the commodity and lower it in quality. One of the resolutions provides for the fixing of a "fair price" at which the light shall be supplied. Unless the arbiters in this case are to proceed somewhat on the same lines as do the Commissioners of the Irish Land Courts, a "fair price" must take into account the contingent extinction of interests. Exorbitant as are the prices charged by gas and water Companies we have at least been spared the extortions of a limited monopoly bound to make all its profits in a given number of years. Neither in the interests of the public nor in those of electric light promoters can we approve of this resolution. The committee stood adjourned to the 8th inst., when they were to consider amendments not controvening the principles of the resolutions at which they have arrived. We shall be curious to learn whether the substance of Resolutions 8 and 10 are maintained as "principles."

ATLANTIC CABLES.

We have before us a circular addressed to the shareholders of the Anglo-American Telegraph Company by an ex-stockholder. Artemus Ward told us that there remained still a "good deal of natur in man," and we might ask, without disrespect to ex-stockholders, Why should an ex-stockholder be so very anxious to influence the actual shareholders? He tells us that he is safe out of the concern, and yet he is generous enough to spend his means in printing and publishing circulars to those who yet have shares to sell. We have lived long enough in the world to look with suspicion upon such actions, and we doubt not that if we could see behind the scenes, "Ex-Stockholder," or someone connected with him, has hopes of making something out of this circular.

It is extremely difficult in most cases to trace misstatements to their sources; they are generally verbal and fleeting, but here we have something tangible, and we can distinctly say the statements are utterly false. The shareholders are told to sell out, and the arguments for this course are derived from a consideration of, as we say, false statements. We do not intend to discuss the whole of this circular, but we may say that, from investigations we have made, a direct denial is given to the statement that certain shareholders have been "refused all information." That the receipts are not contingent upon the company maintaining *four* cables. That the fourth cable is not hopelessly abandoned in the bed of the ocean. That the most eminent electricians do not estimate the life of an Atlantic cable at ten years only. The statements we have referred to are in this circular just the opposite of true. We hear that the "Scotia" has actually picked up one end of the cable in question, and is going on with the work of repair. That surely is not hopeless abandonment. A large number of our readers are interested in cable work and cable property, hence it will not be deemed superfluous for us to have called attention to this circular, and to have pointed out how unworthy of credence it is. Competition cannot well be avoided; it would be well in some instances if it could, and instead of attempting to hamper the management it would be well if some shareholders gave a little more support to those who have their interests in hand. The actions of outsiders should be critically examined, and great care taken not to accept views that are urged by those whose interests are not identified with those of the company.

CORRESPONDENCE.

WHAT IS ELECTRICITY?

Gravitation.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The subject of my present communication is the intimate connection which subsists between molecular manifestations of force—which I have attempted more especially to define in the propagation of light—and terrestrial and universal gravitation.

Every portion of matter attracts every other portion of matter, and the stress between them is proportional to the product of their masses divided by the square of the distance. Such is the law of gravitation, and it is owing to the influence which this universal force exerts, according to accurately-defined laws, upon the heavenly bodies, that their proper motions in relation to each other and to systems are determined; and inasmuch as the force is propagated from one atom to another, from one celestial body to another, each increasing in magnitude and accompanied by stress, we are assured that the generally-accredited doctrine of closed circuits of force cannot exist even in the universe; that the motion of the largest masses is continuous with that of the infinitesimal atom; and that the motion of one mass in the universe cannot occur without propagating its motion, according to the well-defined laws of motion, at least to the other units of the same system.

I shall endeavour now to prove

1st. That universal gravitation is identical with the universal exhibition of magnetic force.

2nd. That each celestial body is a mass of matter which has been condensed by the operation of force from without.

3rd. That after a mass has undergone the full process of condensation, it continues to receive from the sun of the system in which it moves a constant supply of indestructible force, the counterpart of which it returns in the form of stress to the sun.

4th. That every celestial body is charged according to its capacity with this force, which is productive of its mechanical

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life in all its varied phases, and that after performing its work upon the mass it is projected into interplanetary space, to effect work upon other bodies with which it comes into contact.

5th. That the work done upon a mass is effected through the medium of one grand physical law, by means of which each form of matter exerts a *special directive* influence upon force.

6th. That this law manifests its power on the masses by the inclination of the planets on their axes, and is, in fact, the first element in the production of rotation; and then in their orbital motion, whereby the seasons and the various phases of life proper to each are maintained. It is perceived artificially in the atoms of matter by the inclination of bodies when suspended in the field of an electro magnet; in the vegetable kingdom of nature it determines the mode of growth; the production of all shades of colour; and of every variation in form; whilst in the animal world it is exhibited in causing the circulation of the blood; in determining variations in the shape of the blood corpuscles; in differences of species; in the selecting from the plasma of the blood the various elements essential to the formation of each particular description of tissue; in the moulding of those particles into cells under centripetal and centrifugal force; in the evolution of the senses; in the formation of those beautiful spiral ganglia which are formed on the roots of the nerves of sensation, and, in fact, in the carrying out with the most perfect integrity, in accordance with the will of the Almighty architect of the universe, the proper manifestation of every vital phenomena natural and acquired.

I base my theory upon the following data:—

1st. That the celestial bodies are masses of matter, rotating upon their axes whilst moving through space, by which motions momenta are generated in them in directions according with their motions.

2nd. Corresponding motion is imparted to the medium in which they are moving.

3rd. That as we have to do with spheroidal bodies, the motion manifested over each polar hemisphere must assume the form of vortices; that these vortices are right and left-handed according as they are situated to the north or south of the equatorial line, the apices being at the magnetic poles.

4th. That similar vortices of force are extended from the magnetic poles into space, the apices of which are also at the magnetic poles.

5th. That as the force is extended into interplanetary space it becomes more diffused, but is always projected in a direction which varies with the direction of the moving mass, except in so far as it is interfered with by other force emanating from some other body.

6th. That by stress this force projected from a mass must attract force to the mass from without, the direction of which must be opposite and the amount equal to that ejected.

7th. That as these vortices of force depend upon the motion of a mass, it is evident they could not exist if the mass were at rest; *they are consequently secondary to the force which has imparted motion.*

8th. Terrestrial gravitation acknowledges that the celestial bodies, like the earth and its moon, perform their orbital motions owing to force which is imparted from the sun of the orbits in which they move. We, therefore, find that the moon is dependent upon the earth, the earth upon the sun, and as the sun is moving upon the same principle in another but much larger orbit, we have reason to believe that its initial force must be derived from the sun of that system.

9th. For the purpose of substantiating this principle it will be well to confine attention to the sun and the earth. We have, then, to deal with two masses of matter which are rotating upon their axes and in their orbits in the same direction; and further these movements are performed in a medium, the density of which decreases as the distance from the mass increases.

10th. We have next to consider the influence of that enormous force which the earth receives from the sun. With reference to this a recent writer, Dr. Young, expresses it thus:—"If the earth could be suddenly stopped in her orbit and allowed to fall unobstructed towards the sun, under the accelerating influence of his attraction, she would reach the centre in about four months. I have said if she could be stopped, but such is the compass of her orbit that to make its circuit in a year she has to move nearly 19 miles a second, or more than fifty times faster than the swiftest rifle ball; and in moving 20 miles her path deviates from perfect straightness by less than $\frac{1}{8}$ of an inch, and yet over all the circumference of all this tremendous orbit the sun exercises his dominion, and every pulsation of his surface receives its response from the subject earth." And again, with the object of showing the enormous attractive force which the sun exerts upon the earth, I find from some calculations by Mr. C. B. Warring that "if we imagine gravitation to cease and to be replaced by a material bond of some sort, holding the earth to the sun and keeping her in her orbit, and suppose this connection to consist of a web of steel wires, each as large as the heaviest telegraph wires used (No. 4), then to replace the sun's attraction these wires would have to cover the whole sunward hemisphere of our globe about as thickly as blades of grass upon a lawn. It would require nine to each square inch." Now, this enormous force, viz., that which is due to the action of the sun alone is bound to pass through the mass of the earth subject to the laws of motion, and then to be projected as indestructible force into interplanetary space, increased momemtum having been imparted to it by the motion of the earth.

11th. I have already pointed out that the motion of the earth gives rise to momentum in a direction according with its motion, and that this force is extended into interplanetary space, originating vortices in a direction according with the motion of the earth. It will be perceived that the force which is constantly being impressed by the sun upon the earth is in a direction exactly opposite to the motion of the earth; consequently we have the phenomena of force being projected from the earth from both of these sources, and the formation of two vortices at each magnetic pole, the apices of which are in the same situation, but the motions of which are in direct opposition the one to the other. Now, here we have a phenomenon very difficult of apprehension, but perfectly capable of being explained under the influence of mass motion in interplanetary space as above described.

12th. I pointed out in *The Electrician*, June 25th, 1881, that the phenomena exhibited by iron filings under magnetic attraction and repulsion are to be explained by force acting in helical lines, and so far as I have been able to determine, those phenomena could not be represented by force moving in any other manner. It will now be perceived how completely these phenomena which I have demonstrated by means of artificial magnets—*vide The Electrician*, June 25, 1881—accord with the more extended apprehension of the effects of the earth's motion through the lines of force which reach it from the sun, and how perfectly the development of terrestrial magnetism as here set forth agrees with the explanation I was then able to advance as to the cause of artificial magnetism.

13th. In the paper I read at the Physical Society in June, 1880, to which I have referred already, I expressed the opinion that the earth's rotation was due to reaction, and I compared the earth to Hiero's steam engine, but it will be perceived that the force of the sun extends right over the magnetic poles alternately, and that the motion of the earth causes this force to be gathered into vortices at the magnetic poles; vortices which correspond with those described in paragraphs 3 and 4, with the exception that their direction is to the west instead of to the east. Now, these vortices, which result from the force of the sun by the third law of motion, must be designated the action of the sun; whilst those which occur in the opposite direction, and which are caused by, and accord with the motion of the earth establish the consequential reaction. *We thus perceive the principle upon which stress in the earth is the resultant of the force of the sun upon the earth,* and at the same time the cause of those helices of force which are developed at the magnetic poles of the earth, the counterpart of which *in section* may be observed by means of iron filings emanating from the poles of a magnetic bar, and much more completely by the motion of the needle point magnet when placed on the end of a fixed magnet and subjected to the action of a like pole of another magnet

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pushed slowly towards it (*vide The Electrician*, June 25, 1881).

14th. It is also evident owing to the motion of the earth—of which it is the expression—that the force of reaction extends in a helical direction from the magnetic poles of the earth to the line of the ecliptic, and thence to the sun, being the concomitant of the force of the sun throughout; and, further, that the two helical momenta, influences, or lines of force around the north polar hemisphere are left-handed, whilst those round the south pole are right-handed, that is, placing action before re-action. The entire stress of these forces upon the mass of the earth, and its immediate polar surroundings, is capable of being illustrated mechanically in the following manner:—A cylinder of wood, 12in. long by 5in. wide, was turned into a sphere and two half-spheres—with the exception of a central connecting rod—the sphere being in the middle. Two helical grooves were cut on the surface of the sphere, starting from a point equidistant from the half-spheres, one of these grooves being right, and the other left-handed. These grooves were then continued in the same direction, over the half-spheres. A hole was then bored through the sphere, commencing from the point of departure of the two grooves, and another hole at the termination of each groove on the edge of the half-spheres. Four cords—two red and two white—were then run through the central hole and fixed. One cord of each colour was now drawn to the right, and the other two to the left; by rotating the apparatus upon its axis the two cords passing to the right were wound in a left hand helical direction round one half of the sphere, and then, after being fixed by a piece of twine to the bottom of the groove, were continued onwards in the same direction over the adjoining half sphere to the edge of which they were fixed. By the same movement the other two cords had been wound in a right hand helical direction round the half spheres to the left, and were then fixed in the same manner. It will be perceived that if the two red cords represent the force of the sun upon the earth, and the two vortices beyond the poles, the white are representative of the motion of the earth, and of the vortices formed by that motion beyond the poles. The red cords are indicative of action, and the white of reaction. It will be further perceived that the two forces are moving into each other upon the principle of the male and female screws, and are significant of magnetic attraction.

15th. I think I have now made it evident, first, that the force engaged in the production of universal gravitation is helical and precisely of the same character as, and, in fact, identical with magnetic force. Second. It must be evident, if I have stated the facts in accordance with the laws of motion, that each celestial body is a mass of matter which has been compressed from without; for the force of the sun is applied over every portion of the earth's surface in a helical direction. Third. That after a mass has undergone the full process of condensation from such cause it continues to receive from its sun a constant supply of force, the counterpart of which it returns to that sun. Fourth. That every celestial body is charged, according to its capacity, with this force, which is productive of its mechanical life, and is then projected into space to effect other work upon other bodies with which it comes into contact. Fifth. The existence of a physical law, by means of which each form of matter exerts a special directive influence upon force; and that this law is the primary element in the production of motion and rotation.

16th. The question next arises as to what is the cause of two magnetic bodies, each of which is attracting the other with such an enormous force—as is known to exist between the sun and the earth—performing their proper orbital motions without appreciably approaching each other? The answer, of course, at once suggests itself—the development of the centrifugal force; and this is perfectly true. But I submit that the theory now put forth enables us to perceive the *cause* of these things being as they are; that is, why one force, which may be called a repellent force, is caused to attract a mass in exactly the same proportion as it repels; and why the centrifugal force is evolved by the same force under the same principle—the principle which I illustrated in my letter on the propagation of light—by means of a shot placed between two helical wires, and kept rotating upon its axis *in the same spot by the equal motion* of the two wires (*vide The Electrician*). We are thus assured that this one principle pervades the universe, manifesting itself—first, in the propagation of light, and then in universal gravitation, and subsequently we recognise it as the cause of every natural phenomenon, extending itself even to the evolution of vegetable and animal life, nay more, to the development of the mental faculties, for these, in common with every other phenomenon, must be influenced by the character of the matter out of which they spring.

When we realise the fact that all these results are obtained from the directive influence which matter exerts upon force, surely we can only be struck with admiration at the perfection of the mechanism; for it is self-evident that matter and force were created subject to this law, and that with the express object of developing all those phenomena with which we are now so imperfectly acquainted.

In my next letter I hope to make application of this principle of helical force to the physical changes which are known to occur in bodies under variations of temperature.—Yours, &c. RICHARD C. SHETTLE.

Reading, May 26th, 1882.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Johnstone's article shows nothing more than what every schoolboy student of electricity knows, viz., that currents (*sic*) of electricity flow in a fixed direction, and cannot vary except by reversion of the poles.

The denial of the existence of *static induction* is totally unsupported; no proof is given of the current passing *through the glass* of the Leyden jar. The "bending of the two gas flames in one direction" does not *disprove induction*; it only shows the passage of a current, and is no evidence of *electrical matter* passing through the glass of the jar.

The crucial experiment intended to establish the idea of *electrical matter* is a myth. The interference with the ready generation of a current through the jars by the substitution of a pointed wire for the orthodox knob produced only the effect readily surmised without experiment at all, namely, a tardy and interrupted current, due to dispersion through the pointed wire and imperfect charging, owing to the resistance arising from imperfect connection within the jar.

Static induction is not touched in the "experiment," not is the question of *force or matter* affected by it, excepting that such a feeble support of the *latter* idea is a negative argument in favour of the former.—Yours, &c.,

Redhill, Surrey. D. HARBORD.

NOTES AT THE CRYSTAL PALACE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following notes, made by a perfectly impartial observer at the Crystal Palace, may prove interesting to some of your readers:—

(1). That among all the arc lights the "Pilsen" appeared to be undoubtedly the steadiest.

(2). That the lamps of Messrs. Siemens Bros. are entitled to take the second place, and that both systems are far in advance of their other competitors.

(3). That Notes 1 and 2 are strong evidence in favour of the differential system, to some extent similar in both these lamps.

(4). That the Brockie lamp shows to much better advantage there than it did in Liverpool, where it had made a very bad impression.

(5). That the Jablochkoff can still compete with the great majority of systems, notwithstanding the fact that its death-knell was supposed to have been sounded at Paris.

(6). That the writer was extremely disappointed with the performances of Mr. Crompton's lamp.

(7). That all users of the light should avoid the Brush;

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their machine room, though brilliantly lighted, was extremely trying to the sight.

(8). That the Joel semi-incandescent light is extremely useful, and for certain purposes would be without a rival; when seen by the writer not the slightest flicker could be observed. It is said to consume about half a horse-power per light, requiring a current of 45 ampères through a resistance of about ·15 ohm, and giving a light equal to about 250 to 300 candles.

(9). That among incandescent lamps Swan, by making his carbons carry a current of 1·34 ampère, produces a light far superior in quality to any of the others, and that if at this temperature his lamps have a lasting power equal to the other systems it follows that the quality of the carbons must be better and the light more economical, but on this point no evidence is forthcoming.

(10). That the shape of Maxim's carbon is the best for giving an equable light, but that the price of the lamp is absurd.

(11). That the horse-power required to produce a very moderate degree of illumination in the rooms of the Domestic Electric Lighting Company is appalling to contemplate.

(12). That Messrs. Crossley Brothers' exhibit of one of their half-horse nominal gas engines driving a Siemens dynamo feeding ten Swan lamps is very interesting, and calculated to give a fair idea of the power required; the engine indicates $1\frac{1}{2}$ h.-p.

Dynamo Machines.

(1). The array shown by the Brush Company is most imposing, and their workmanship leaves nothing to be desired; their very high E.M.F. causing them to spark considerably at the commutators.

(2). That the British Electric Light Company have adopted the flat or oval section for the field magnets of their Gramme machines in preference apparently to the original round section.

(3). That it speaks volumes for Siemens machines that they are used by so many independent exhibitors.

(4). That it seems peculiar to find most of Siemens's new machines are upright, and most of the British Electric Light Company's new machines are horizontal.

(5). That we should like to know how long it would take for the power saved in Edison's machines by using his large magnets to pay for the extra material, and that we hope very few people will be so hasty as to pay £200 for one of them.

(6). That the Burgin machine will probably stand more wear and tear than most of the others, but is shrewdly and naturally suspected of absorbing rather more than its share of power.

(7). That the price of all dynamo machines of the present day is altogether too utter to tempt the majority of persons to whom the light would be otherwise an advantage.

Telephones.

That it is utterly impossible to find anything but the Gower-Bell, which is the more annoying as this instrument is *not to be compared* for efficiency with the Blake and Bell combination, which we have in our offices in Liverpool.—Yours, &c. G. A. Moore.

[We insert this letter more to give a specimen of the conclusions come to by an outsider than for its intrinsic value. It may, however, be well to say that, unless the arc lamps were burning the same kind of carbon, and not, as was really the case, some lamps burning the very best French carbons, while others were burning ordinary English made carbons, such a rough and ready test is wholly misleading. Change the carbons, and the chances are you completely alter the performances of the lamps. —Ed. *E.*]

NEW LAMPS, COMPANIES, &c.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: It would be very interesting to those who are following the history of electrical inventions if the promoters of the Self-Generator, Duplex, and Fyfe Main Companies would vouchsafe answers to the following questions:—1st. What is the self-generator for which the sum of £80,000 in cash and £40,000 in shares is asked—is it a dynamo machine, or is it a galvanic battery? again, 2nd. What is the Duplex system? where and how is it employed? and can it be seen at work? 3rd. In what points does the Fyfe Main lamp differ from the Crompton lamp as exhibited by Messrs. Crompton in Paris?—Yours, &c., X. Y. Z.

London, E.C., June 8, 1882.

A TIDAL WHEEL FOR MOTIVE POWER.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: While speaking to Mr. Cannon, to whom I believe you are known, he mentioned that you had suggested the use of tidal rivers as a motive power by which electricity might

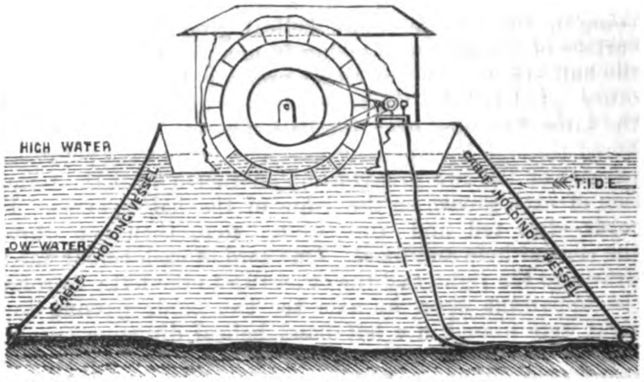

Fig. 1.—Water wheel for tidal rivers supplying current to Faure accumulators during the day. The accumulators to be used at night for lighting purposes.

be stored in Faure's secondary batteries, and used for lighting and other purposes. I take the liberty of enclosing a sketch of a simple yet effective means by which I believe those ends could be attained. You are at liberty to make whatever use you like of it.

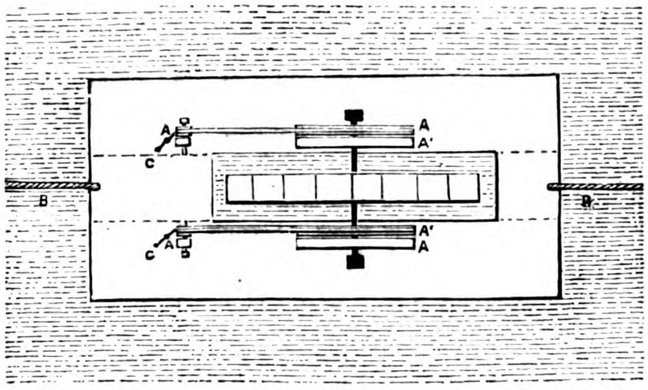

Fig. 2.—Ground plan of water wheel. A A, loose wheel and pulley; A' A', fixed wheel; B, cable for holding vessel; C C are levers for moving the driving belt from the loose to the driving pulleys of the dynamo machine which is supposed to be placed between C C.

You will see on referring to the ground plan that on the tide turning the bands are changed, so that the small band wheel of dynamo machine runs always the same way.

I should be pleased to hear your opinion meantime.—Yours, &c., Vincent A. Wraight.

2, Cannon-street, May 19.

Electric Light on a Yacht.—The yacht "Namouna," belonging to Mr. J. Gordon Bennett, of New York, has been fitted with 120 Edison B lamps of eight candle-power. The dynamo is driven by a special engine supplied with steam from either the main boilers or the donkey boiler, the exhaust steam being delivered either into the condenser or through the side of the vessel. The lamps are arranged in the cabins and saloons, engine room, &c., and also in the shaft alley. The lamps in the engine room are furnished with long flexible conductors, so that they can be carried out, and the machinery examined by their light.

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THEORY OF MAGNETO AND DYNAMO MACHINES.

XV.

In last week's article the letter N was used in two senses, by inadvertence. Its original sense was the number of lines of force passing through any contour—or the potential of the contour—but last week it was also used to signify merely the number of turns of wire on a coil. For this last, therefore, we must devise a fresh symbol; n is already at work and ν is unsatisfactory, suppose we try K; and let us proceed to re-write the equations expressing the resistance, the E.M.F., the current, and the power, concerned in a revolving coil of diameter D; which contains M grammes of wire of specific resistance r and specific gravity ρ wound in K turns; and which is spinning n times a second in a magnetic field of intensity I.

And we will take this opportunity of putting those expressions into other equivalent and instructive forms, by introducing explicitly the thickness and length of the wire on the coil. Let the length be called l, and the cross sectional area of the wire a; then since $M = l\,a\,\rho$, and $K\,\pi\,D = l$, we have

$$R = \frac{l\,r}{a} = \frac{K\,\pi\,D\,r}{a} = \frac{M\,r}{a^2\,\rho} = \frac{l^2\,r\,\rho}{M}$$

$$E = n\,I\,K\,\pi\,D^2 = n\,I\,D\frac{M}{a\,\rho} = n\,I\,D.l$$

$$\gamma = \frac{n\,I\,M}{K\,\pi\,r\,\rho} = n\,I\,D\,.\frac{a}{r}$$

$$P = (n\,I\,D)^2\,.\frac{M}{r\rho}.$$

All these expressions are instructive if one takes the trouble to examine them. They show, for instance, that with a coil of given size the E.M.F. is directly proportional to the length of wire used, the current to its sectional area, and the power necessary to turn the coil to its bulk. Further, that the E.M.F. and the current are each simply proportional to the rate of rotation, the strength of the field, and the diameter of the coil; while the power is proportional to the square of these same quantities.

The units in which all the above quantities will appear if everything is measured in centimetres, grammes, and seconds will be absolute measure; but it is easy to get them into practical units.

To get E in volts you must divide the above expression for it by 100,000,000. To get γ in amperes you must multiply its above expression by 10. While to get P into horse-power you must divide by 7,460,000,000, if you please (*see* Art. XI.).

It may further be convenient here to record that for every horse-power running to waste 177·62 thermal units per second are generated.

We will leave the revolving coil for the present, but shall return to it, because it will obviously lead us up to the consideration of a revolving armature.

Turn back, now, to Art. IV., p. 118, and consider the wheel and rails of Fig. 1. If the axle moves with velocity v over a distance x, $V\,b\,x$ fresh lines of force are added to the circuit (V being the vertical intensity of the earth), and the *rate* of adding lines is $V\,b\,\frac{x}{t} = V\,b\,v$; hence this is the E.M.F. tending to produce a current.

In the pendulum of Fig. 2, the rate of adding lines of force $\left(\text{or}\,\frac{dN}{dt}\right)$ is evidently $\frac{1}{2}\,H\,l^2\,\frac{d\,\theta}{d\,t}$; so this is the electromotive force producing the induced current due to the motion. Similarly, the E.M.F. in the rotating disc, Fig. 3, or the revolving wire, Fig. 4, rotating in a field of average intensity I with the angular velocity ϵ, is $\frac{1}{2}\,r^2\,I\,\epsilon$.

All these are contrivances which will move when a current is supplied by a battery, and which will induce a current themselves when moved by hand. As motors we considered them before; as inducers of a current we consider them now.

In Art. VIII., p. 205, are two other contrivances, Fig. 6 and Fig. 7. In the symbols there employed, and on the supposition that the magnets may be treated as ideal ones, with the poles practically points, the E.M.F. of induction when they are turned by hand with angular velocity ϵ, or n times a second, may be written at pleasure in any of these ways:—

$$2\,m\,\omega\,n = \frac{m\,\omega\,\epsilon}{\pi} = 2\,m\,\epsilon\,\frac{s - a}{s} = 2\,m\,\epsilon \text{ vers } \theta, \text{ for Fig 6.}$$

and

$$2\,m\,(2\,\pi - \omega)\,n = \left(2 - \frac{\omega}{\pi}\right)m\,\epsilon = 2\,m\,\epsilon\,\frac{s}{a} = 2\,m\,\epsilon \cos\theta, \text{ for}$$

Fig. 7.

The angle θ, it will be observed, is the plane angle subtended by the radius of the trough at either pole. Now, the smaller this angle the better, whether we wish the thing to act as an electro-magnetic engine or as a magneto-electric machine. Hence, we can with advantage do away with all mercury troughs and other complexities, and construct the simplest possible of all magnetic motors by taking a round bar magnet, pivoting it at its two pointed ends, and letting a light rubbing contact rest against its middle. If it be now spun by hand n times a second (each of its poles being of strength m), a current will be urged from the middle to either end, with the E.M.F. $4\,\pi\,m\,n$. If, on the contrary, a current γ from a battery be sent in at one end (or both) and out at the middle, the magnet will begin to rotate, with the moment $2\,m\,\gamma$.

THE CRYSTAL PALACE EXHIBITION.

The Edison Exhibit.

Although we had heard much of Edison's light, few of us had seen it until the present year. True he made a grand display at Paris, but thousands who have now seen the light could not go to Paris. From the evening when the concert room was first lighted up before a select audience till the present moment the attraction of the Edison display has been one of the most prominent in the Exhibition. The designers of the exhibit, Mr. Johnson, the representative of Mr. Edison in England, and Mr. Hammer, the engineer, intended to make the exhibit attractive, and they have been successful, aided by Messrs. Verity and Sons, of King-street, Covent-garden, who designed and manufactured the ornate "electrolier," &c., in the Entertainment Court.

The exhibit comprised about 1,080 lamps, two-thirds of the lamps being of 16 candle-power, known as A lamps, and the remainder of 8 candle-power, known as B lamps. There were also a number of lamps of 32 and 50 candle-power, as well as lamps of various forms, of different kinds of carbon, with carbons arranged in various ways in the globes, specimens, in fact, at once interesting and instructive. The space set apart for the Edison exhibit was, we believe, considerably larger than that occupied by any other exhibitor at the Palace, and consisted of (1) The Entertainment Court, which was lighted by 250 lamps, arranged in every conceivable form, from the huge electrolier or basket of flowers, with its 99 lamps, down to the tiny lamp which might be run with a small battery or accumulator.

The application of the Edison lamp to artistic decorations and fixtures was shown on a large scale from designs, as we have stated, prepared by Messrs. B. Verity and Sons, of King-street, Covent-garden, by whom the work was carried out in a very able manner.

Besides several special features, such as stage footlights, hall lights, billiard lights, &c., the Entertainment Court contained a number of Mr. Edison's inventions in connection with telegraphy, the telephone, and phonograph, as well as many other valuable discoveries.

Many of the Edison exhibits were shown at the recent Paris Electrical Exhibition, and formed one of the chief features of interest there.

Next in importance to the Entertainment Court, which was one of the chief attractions to all sightseers, was the large concert room lighted with 240 lamps, hung in festoons around the galleries and a magnificent crystal chandelier, which alone contained 83 lamps, besides numerous small

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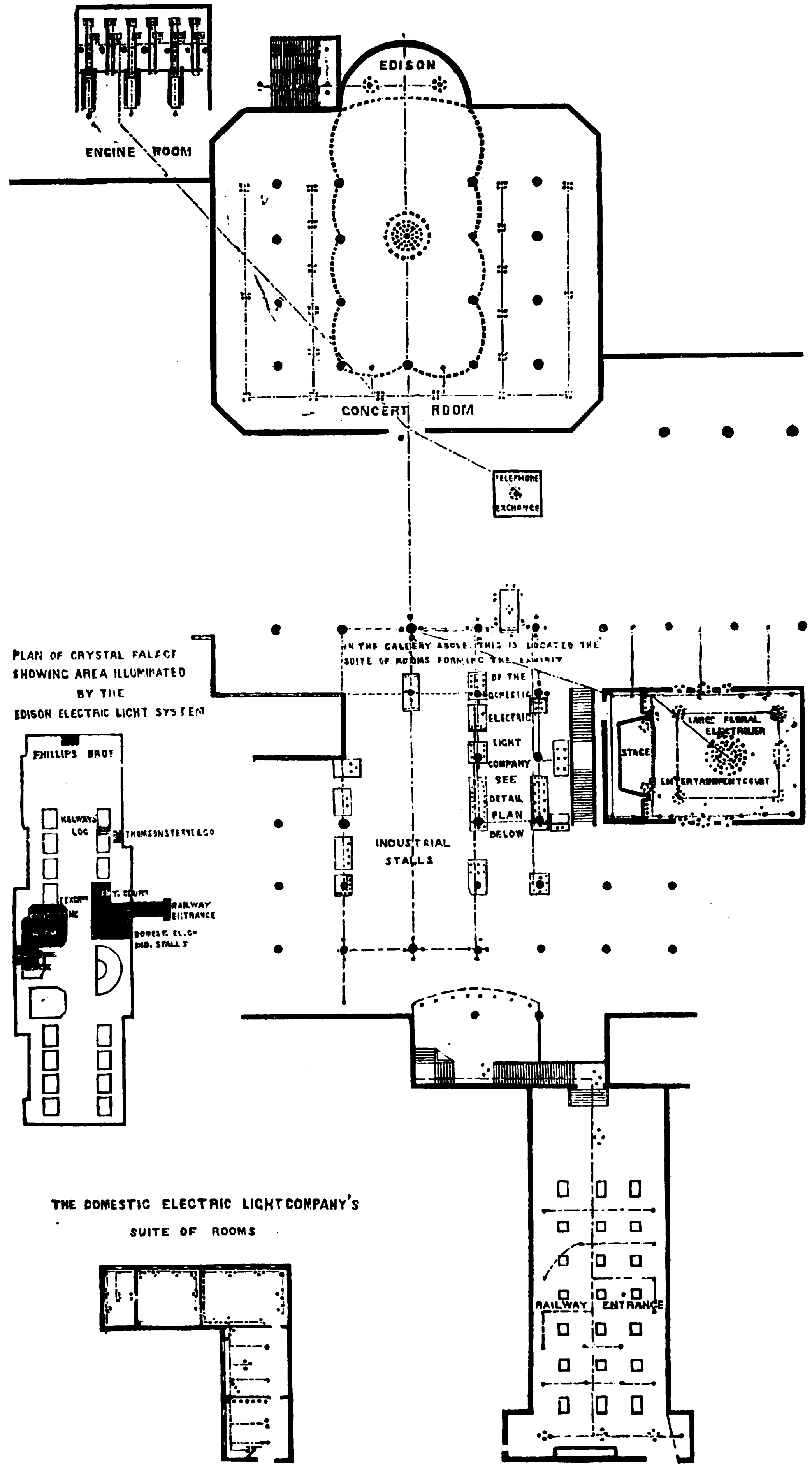
chandeliers suspended underneath the galleries, while over the stage were suspended two handsome fixtures, thus afford-



ing ample light for the orchestra. In front of the organ the name "Edison" was effectively displayed by means of 64

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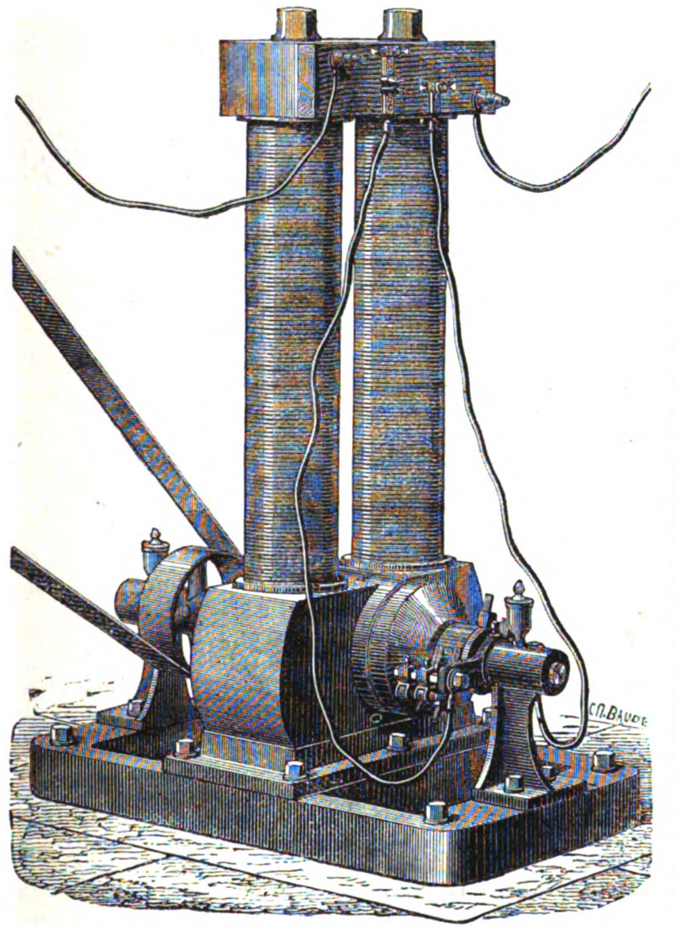
eight-candle lamps. Notwithstanding the size of this large room the lights employed were ample for a brilliantly soft illumination, and the appearance presented was superior to any effect which could be produced by means of gas, and probably arc lights, even under the best conditions, would fail to be so pleasant and agreeable. We must confess that the chandelier in the centre of the concert room always seemed to us one of the prettiest exhibits in the building.

The Industrial Court comprising the booths, stalls, &c., fronting the concert room and extending to the High Level Railway entrance was lighted by Edison lamps attached to the existing gas fixtures, and suspended in various ways. The archways leading from the London, Chatham, and Dover Railway to the Palace were effectively lit up, the lamps being hung from the ceilings. Visitors leaving the Palace would also observe the approaches to the Palace from the railway illuminated by Edison lamps, whilst in the railway station could be seen a single suspended lamp enclosed in a transparent globe showing forth the inventor's name.



Edison's Dynamo.

A most important feature was the lighting of the suite of rooms artistically furnished for the Domestic Electric Light Company by several firms of high standing. An opportunity was here afforded to demonstrate the application of the Edison incandescent light for domestic purposes. The lighting of these splendidly furnished apartments was very much admired, and added very considerably to the general attractions of this exhibit.

The shrubbery near the Entertainment Court was also lighted with lamps enclosed in glass globes containing coloured solutions, the effect of which was extremely pretty.

The Telephone Exchange, situate in the Grand Nave, was effectively lit by a huge æsthetic sunflower studded with small Edison lamps. Other exhibitors at the Palace were also supplied with Edison lamps, including Messrs. Phillips Brothers, whose stall in the gallery at the opposite end of the building under the large clock was lit from the Edison central station. The application of Kelway's electric log was also shown, with Edison lamps burning under water in a large tank, in which the apparatus was placed. Messrs. Thompson, Sterne, and Co., also exhibited a number of Edison lamps run by a dynamo driven by a Clerk gas engine.

The whole of the Edison lights exhibited in various parts of the building were under immediate and independent control, and might be raised or reduced as required, each lamp and each circuit being provided with an Edison protection plug, consisting of a piece of lead wire, inserted at each circuit, which melts at a low temperature and prevents any danger either from malicious or accidental contact or short circuiting of the wires. This method of protection is due, we believe, to Mr. Edison, and is one of very great importance, and plays a prominent part in the completeness of his system.

Not the least important and attractive feature of the Edison exhibit were the dynamo machines which were to be seen on the floor underneath the concert room. This plant consisted of twelve of Mr. Edison's 60 light dynamos, arranged in sets of four, each set driven by a 25 horse-power nominal Robey engine. The engines worked upon a counter shaft provided with friction clutches so that one or more machines could be thrown out of circuit without affecting the others. This plant was arranged in order that, in the event of the failure of one machine, or the stoppage of an engine, a margin of reserve could be at once called upon. The machines were arranged in multiple arc and connected with an Edison regulator, an ingenious device for regulating the strength and efficiency of the magnets of the respective machines. As was frequently done for the purpose of demonstrating the utility of this regulating device, an engine was stopped and the remaining engines brought up nearer to their maximum capacity, and the deficiency made good. This was done with scarcely any perceptible effect upon the light.

A good illustration of the facility with which the lights were controlled was shown in the concert room on the occasion of the course of lectures delivered there, during which time the whole of the lights were repeatedly put out at a signal given by the lecturer, in order to show upon a screen diagrams, &c., used for the purpose of these lectures, and although 150 lamps were thus extinguished and relit at frequent intervals during the delivery of the lectures, the operation had scarcely the slightest effect upon the lights in use in various other departments of the exhibit, and were manipulated without any communication being made with the engineer-in-charge of the dynamo machines.

The conductors used for carrying the electricity to the various sections of the exhibit consisted of two half-round copper conductors enclosed in an iron tube, and surrounded by an insulating compound of very high resistance. These conductors are similar to those employed by Mr. Edison in New York (which have been previously illustrated by us), where some thirteen miles have just been laid in the streets, and which, after having been covered up several months, test perfectly.

It might also be added that these Edison electric tubes, as they are called, are employed on the Holborn-viaduct for distributing the electrical current to the various shops, hotels, &c., along the Viaduct from Old Bailey to Hatton-garden Circus.

It may be pointed out that the Edison exhibit was one of the first ready. We believe the Electric Light and Power Generator Company was actually the first to light up, and was quickly followed by Edison. We are quite sure that many of our English firms might with advantage copy a little of the energy that has been thrown into this exhibit. It reminds us of our schoolboy days, when, trusting to a quick apprehension and a good memory, *amo* and *tupto* were shirked for cricket and football, bringing again and again upon us the denunciation of our masters, one of whom was constantly reminding us that it was seldom the clever child of the family turned out to be the best citizen, but the one who attended regularly and consistently to his work. The plodding boy, not the youthful prodigy, was with him the favourite. Edison and his colleagues—for such they are—have steadily and determinedly faced their difficulties, have

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worked hard, and so far have been awarded a fair meed of success in popular estimation. Their motto is evidently *aut Cæsar aut nullus.*

MAGNETIC PROPERTIES OF MILD STEEL.

In a paper on "Certain Physical Tests and Properties of 'Mild Steel,'" read by Mr. Edward Richards at the annual meeting of the Iron and Steel Institute, held a few days ago, the author says:—"Before concluding this paper it may not be out of place to refer to some magnetic indications which may be observed in the process of making tensile tests on steel bars. A short bar of the mild steel used in these experiments, when placed in the line of the magnetic meridian, and held at the same time in the line of dip, is acted upon inductively by the earth's magnetism, and exhibits the attractions and repulsions of a true magnet, the north and south ends having north and south polarities respectively. Holding the bar in the same position, but reversing the ends, it is still magnetic, the ends pointing north and south having again north and south polarities. If one end of the bar be marked and the bar be reversed repeatedly, the polarity of the marked end will be found to be changed at each reversal. In this respect the metal behaves in exactly the same manner as the softest and purest quality of iron. Placed at right angles to the magnetic meridian, the polarity of the ends disappears, but the bar is found to be feebly magnetic, the lower side of the bar towards the north showing north polarity, and the upper side on the south the opposite polarity.

"It happens that at the Barrow Hematite Steel Company's Works the Kirkcaldy testing machine is placed north and south, and as the machine occupies a space more than a dozen yards in length, the different parts of the machine behave generally as a magnet. Upon testing a cylindrical bar of mild steel up to the point of rupture in this machine, the induced magnetism of mild steel becomes somewhat intensified with the rearrangement of the molecules under strain, and with the increase of elasticity; moreover, the magnetism becomes fixed. When the specimen is removed from the machine, either as a whole or in two broken pieces, it is permanently magnetic; the end which was towards the north having north magnetism, that is to say, it will attract the south end of a magnetic needle, and will repel the north end, no matter in what position the bar may be placed. With the aid of a small magnetic compass it is, consequently, easy upon trial to determine which end of a specimen was placed towards the north during tension. This behaviour is, of course, easily understood, but the author is not aware that it is generally known to be a constant occurrence in the process of testing steel bars or plate specimens.

"The position taken up by a small magnetic needle when placed in different positions near to a cylindrical specimen of mild steel undergoing test changes a little as the extension proceeds, and when the bar is broken the ends of the needle move through a very large angle, in some instances through a semicircle, taking up the opposite direction to that which they occupied before rupture took place. Placed east and west, the magnetism is not developed to any extent during tension, providing the surrounding parts of the machine have no magnetism. This was proved, at the suggestion of Mr. J. T. Smith, manager of the works, by testing a bar of steel in a small Whitworth testing machine placed at right angles to the magnetic meridian. Steel under compression also becomes permanently magnetic, the polarity of the bar being determined by the polarity of the magnetic field in which the specimen is placed during compression."

An Electric Tramway.—The Portrush and Bushnels Electric Tramway, near Belfast, the first that has been constructed in the United Kingdom, will be opened in the first week in August. The ceremony will probably be performed by the Lord-Lieutenant.

ELECTRICAL ACCUMULATORS OR SECONDARY BATTERIES.*

BY PROFESSOR OLIVER J. LODGE, D.SC.

No. I.

A battery is an arrangement for setting electricity in motion, *i.e.*, for producing an electric current by means of chemical action. It generally, or always, consists of a liquid able to conduct electricity and of two solid conductors immersed in it, on which it is able to act chemically. If the two conductors differ in the smallest degree in respect of their chemical affinity for some active constituent of the liquid in which they are immersed, then, as soon as they are joined by a wire, a current is always found to flow—strong or weak, according to the degree of the difference between the surfaces of the two conductors, and also according to the dimensions and nature of the connecting wire and of the conducting liquid.

The distinction between a primary and a secondary battery is in no sense an important one when we are considering either as the producer of a current; and we may have in our minds an old Volta cell, or a Smee, Grove, or Daniell, just as satisfactorily as a Planté or a Faure, while we consider the ensuing few theoretical remarks.

I shall use the term "radicle" in preference to "element," as being more general. Radicles may be elementary, but they may also be compound. The atom of hydrogen, of oxygen, or of lead, is a radicle, but so is the group $S\,O_4$ or $N\,O_3$. A radicle is any group of atoms that can combine, or be removed from combination, with another group. Chemists have long been accustomed to divide radicles into electro-positive and electro-negative, or "basylous" and "chlorous," though they have been slow to recognise the full physical meaning of this distinction. They have also classified them into monad, diad, triad, radicles, and the like; and, without entering into the disputed question of whether atomicities are fixed or variable, it is absolutely certain that in a definite compound, and when released from definite compounds, certain radicles are monad, diad, or triad, as the case may be.

It is, moreover, known that radicles can exist temporarily in the free state, when they are said to be dissociated; and that many liquids—not to speak of gases—contain a number of such dissociated molecules, the number depending on the temperature as well as on the nature of the liquid, and being on the average pretty constant—that is, they are equally distributed through the whole liquid, and if some are by any means removed more will at once be formed to keep up the average. Not that any one radicle need remain long dissociated—there is, no doubt, a continual interchange—but the average number dissociated is definite under definite physical conditions.

Now there is a large class of liquids whose dissociated radicles are all charged with electricity—half of them with positive, and these are they which chemists call electro-positive or basylous radicles—half of them with negative, called therefore electro-negative or chlorous. Moreover, it was shown by Faraday that the charge possessed by every monad radicle, of what kind soever, is precisely the same in quantity, though it may differ in sign; and that diads have twice, triads thrice, this atomic charge, and so on. The existence of these charges is certain from the facts of electro-chemistry, and the electrical charge appears to be the essential condition for even the momentary existence of a free radicle. It further appears that when two opposite radicles combine their charges are either lost or are masked by proximity; and that before two radicles of the same kind can unite into a molecule their charges must be given up to some third body. A liquid which possesses such dissociated and oppositely charged radicles, sauntering about in it, is *ipso facto* susceptible of being decomposed by electrical means, and is called an electrolyte. Liquids which have no such charged and dissociated molecules are not electrolytes, and will not conduct electricity. Electrolytes conduct electricity by a bodily transfer in opposite directions of the oppositely charged radicles; they conduc

* We reprint these excellent articles from the *Engineer.*

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it, in fact, as a convection current, or rather perhaps of two equal opposite convection currents, one of the positive radicles the other of the negative. The resistance of the liquid depends upon the slow shearing asunder of these two sets of radicles by a process closely analogous to diffusion, for it is possibly only assisted or directed by electricity in the immediate—molecular—vicinity of the electrodes.

What are these electrodes? They are conductors introduced into the liquid, with the property of exerting upon the charged radicles in their immediate neighbourhood unequal, or else opposite, forces. Thus, suppose they are two plates of platinum connected with a battery, so that one plate is always +, the other always −; and suppose for simplicity that the dissociated radicles are hydrogen—electro-positive, and oxygen—electro-negative, respectively. Oxygen atoms close to the positive electrode are attracted by it; they deliver up their charges to it, and uniting into molecules, rise as gas. Their places are taken by others from the slightly more remote region, and so on, a virtual procession of oxygen atoms continually taking place towards the positive plate, each carrying its charge with it. The same thing happens on the hydrogen side, only that twice as many hydrogen atoms take part in the action, the charge of each being half that of an oxygen atom.

This, then, appears to be the state of things in ordinary electro-chemical decomposition; only the radicles liberated on the surface of the electrode will combine with it, if in any way possible, instead of merely combining with each other and becoming free. Thus the hydrogen alloys itself as well as it can with the platinum; and the oxygen, if it finds any copper or other less noble metal on the surface of the electrode, will readily combine with it; the ordinary chemical affinities being enhanced by the electrical attractions.

But now, instead of two oppositely charged plates of the same material, let us immerse in the liquid a plate of zinc and a plate of copper, or any two metals which have a different affinity for oxygen. The oxygen atoms are now attracted to the zinc just as they were to the positive plate, but apparently by a chemical, not an electrical, force. It may be possible ultimately to reduce chemical forces to electrical ones, or *vice versâ*; but at present it seems necessary to draw a distinction between them. This attraction for the oxygen is, as before, only to be supposed to be effective within far less than a microscopic distance of the plate. The replenishment of the oxygen into this region is wholly carried on by diffusion and fresh dissociation. The copper on the other side pulls the oxygen too, but less powerfully. Nothing more than slight motion and very slow combination, however, is found to go on so long as the two plates are kept separate, provided both are pure and homogeneous; but the tending of the negatively charged oxygen towards the zinc makes it transfer negative electricity to the copper as soon as they are connected by a wire.

The copper so connected, being now negatively charged, actually repels the oxygen atoms, and is protected from their attack, while it attracts the hydrogen. We now therefore have the continuous opposite processions again, the oxygen atoms combining with the zinc, and neutralising by their charges positive electricity at its surface, in other words, partially giving up negative electricity to it; the hydrogen atoms going to the copper, hydrogenising it to some extent, but soon giving up their positive charges to it, uniting with each other and escaping from the liquid. A constant current must therefore be flowing along the connecting wire, of negative electricity from the zinc to the copper, of positive from the copper to the zinc.

Next, suppose two plates of the same metal, say both platinum or both lead, not connected with any battery, but with their surfaces in different chemical conditions—say one coated with hydrogen, the other with oxygen. Plainly the same kind of action can go on. The oxygenised plate will be attracting the hydrogen like the copper, or like the negatively charged plate connected with the pole of a battery; the hydrogenised plate will behave like the zinc or the positively charged plate. The positive current will flow along the connecting wire from the oxidised plate to the hydrogen-coated one.

We have thus a battery which will maintain a current so long as the plates continue coated or combined with the two gases; but the action of the current is obviously to destroy these gases and restore the plates to a condition of equality. A battery may be made, then, either of two different metals, one of which attracts oxygen more than the other—this case we will not now further consider—or else of two pieces of the same metal, one more oxidised than the other, or one more hydrogenised than the other; or, still better, one oxidised and the other hydrogenised. Take, for instance, two plates of lead and immerse them in dilute sulphuric acid; let one be bright and metallic, the other rusted over with a coat of oxide of lead. As soon as metallic communication is made between the two plates, a positive current of electricity continually flows along it from the oxidised plate to the other, the bright plate becoming gradually oxidised and the other becoming gradually reduced. If the plate has been oxidised by exposure to hot air, or by ordinary chemical means, such a battery would be called a primary one; if the coat of oxide has been produced by passing through the cell an electric current from some independent source, then the battery is called a secondary one.

I will next week consider more particularly the constitution and detailed behaviour of such secondary batteries.

Queen's College, Liverpool, May 16.

THE COST OF ELECTRIC LIGHTING BY INCANDESCENCE.

The following letter from Mr. W. Crookes, F.R.S., appeared in *The Times* for June 5:—

"Sir: For more than six months I have had the principal reception room in this house (7, Kensington Park-gardens, W.) almost exclusively lighted by incandescent electric lamps, the electricity being generated on the premises; and as so many different opinions have been given as to the expense of lighting by incandescent lamps, some saying that electricity is many times more expensive than gas, while others maintain that it is cheaper than gas, the results of my own private experience in electric lighting may not be without interest.

"The dynamo machine—a small Bürgen—is driven by a 3½ horse-power Otto gas-engine, which in favourable circumstances will develop 5 horse-power. Owing to the absolute necessity which exists in a private house in this neighbourhood that there should be no smell of unconsumed gases, and no noise of machinery either in the house or out in the street to annoy my neighbours, it became necessary to add silencing chambers to the air inlet and the exhaust pipe, and to carry the products of combustion high up on to the roof. The obstructions thus put in the way of the free working of the engine necessarily affect the horse-power, so that when a further deduction is made for the power absorbed in running the machinery when no electricity is being generated, I find I have not more than 2 horse-power available for the production of electricity. This is far from sufficient to drive the dynamo machine to its full power, therefore I lose greatly in efficiency both in the engine and the dynamo machine. However, I have only to deal with the facts as they show themselves in my experience. The total necessary expense of the installation has not exceeded £300, including wiring the house and making the lamps, although the actual expense to me has been much more, as I had to excavate and build underground rooms for the machinery. Where stables or out-buildings are available, or if a little noise is not prohibited, a less expense will give more available electricity, and where steam power can be used the cost will be diminished fourfold. The gas engine requires five minutes' attention every day to fill the oil cups and start it. Once started, it will go on without attention for six or eight hours. It is overhauled and cleaned once a week; an engineer does this on a Saturday afternoon, at a cost of 2s. 6d.

"The *maximum* electric current which I can get is 11·5

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amperes through an external resistance of 12 ohms. The lamps fed by the current are distributed as follows:—In the library I have 11 20-candle lamps; in the dining room I have 10 20-candle lamps; in the drawing room I have a cluster of 21 4-candle lamps in an electrolier in the centre of the room and five 20-candle lamps. One or two lamps are in other parts of the house; the total number of lamps about the house being about 50. I cannot, however, have this number alight at once, as the machine as at present driven will not feed so many. It is, however, sufficient to light any two rooms perfectly, and the third partially.

"Switches are placed in cupboards in each room so as to turn any desired combination of lamps off and on. Main keys, cutting off the whole of the current at once, are placed in the engine room, and also in my laboratory at the place whence the main wires diverge to the different rooms.

"Owing to inexperience in adjusting the strength of the current to the kind of lamp used, and to the variety of systems, &c., I was then testing, the breakages during the first three months were somewhat numerous. For the last three months, however, since passing the experimental stage and settling down to a definite system, I have used lamps made by myself, and during this time only one lamp has gone.

"The gas burnt in the engine when the machine is feeding its *maximum* number of lamps (22 20-candle lamps) is about 550 cubic feet in five hours, costing, at 3s. 2d. per thousand, 1s. 9d. Assuming that the light is required on an average five hours a night all the year round, this would come to £2 9s. a month, or £31 17s. per annum.

"To obtain, not an equal amount of light, but a fairly good light from gas, to replace this amount of electric light, would take 30 gas burners, each burning 5ft. per hour, or 750 cubic feet in five hours, costing 2s. 4½d., or £3 6s. 6d. per month, or £43 4s. 6d. per annum.

"The expenses, therefore, per month stand as follow:—Electricity—Gas consumed in engine, £2 9s.; engineer once a week to clean and oil machinery, 10s.—£2 19s. Lighting by gas alone, £3 6s. 6d. Balance in favour of electricity per month, 7s. 6d.; or per annum, £4 17s. 6d.

"I have here charged only the current expenses. Strictly speaking, I ought to charge interest and wear and tear, but these are more than counter-balanced by the incidental advantages of electric lighting. With it the ceilings do not get blackened, the curtains are not soiled with soot and smoke, the decorative paint work is not destroyed or the gilding tarnished, the bindings of books are not rotted, the air of the room remains cool and fresh and is not vitiated by the hot fumes from burnt or semi-burnt gas, while fire risk is almost annihilated, as no lucifers are used, and the lamps are high up out of reach.

"In the above statement, I have compared electricity with gas as an illuminating agent. This is giving gas an unfair advantage. The 21 electric lamps in my drawing room do not replace gas jets, but wax candles, while the incandescent lamps in the dining room replace candles and oil lamps. The actual expense of these per night comes to three or four times the cost of electric illumination.

"Moreover, I am producing my electricity at an extravagantly dear rate. The dynamo machine works only about half power, and this greatly reduces its efficiency; while Messrs. Crossley tell me that a consumption of over 100ft. of gas per hour ought to give me double the power I get out of the engine; and doubtless it would do so were it not for the back pressure produced by the silencing boxes.

"When electricity is laid on to our houses as gas is all these extra expenses and difficulties will disappear; and if, as I hope I have shown, electricity, heavily handicapped as it is in a private house, compares favourably with gas even in the matter of cost, it will necessarily be far cheaper than gas when it is supplied wholesale from a central station."

ACCIDENT BY LIGHTNING.—At Peterborough on Saturday evening during a severe thunderstorm a woman, named Ann Smith, whilst walking through one of the streets of the town, was struck by lightning and instantly killed.

AUSTRALASIAN ELECTRIC LIGHT, POWER, AND STORAGE COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on the 5th inst., at the City Terminus Hotel, under the presidency of Mr. Randolph C. Want, when the following resolutions were submitted for confirmation:

1. That this Company so far modify the conditions contained in its memorandum of association as to consolidate the 5,000 founders' shares of £1 each into 1,000 founders' shares of £5 each.

2. That the 36th of the Articles of Association of the Company be amended by striking out the figures "5,000" on the 4th line of the 42nd page of the said articles, and by substituting the figures "1,000" in lieu thereof, and that the word "five" in the sixth line of the same page be struck out.

3. That the 108th of the Articles of Association of the Company be amended by striking out the figures "5,000" in the third line of the 47th page of the said articles, and by substituting the figures "1,000" in lieu thereof, and that the letters and figures "£1," in the same line of the said articles be struck out, and the letter and figure "£5" be substituted therefor.

The SECRETARY (Mr. J. H. Duncan) read the notice convening the meeting, and

The CHAIRMAN, in proposing the confirmation of the resolutions, stated that the alterations were merely owing to a clerical error. He might mention that they had sent out a very able and influential gentleman to the colonies to make arrangements there, and the news from the colonies showed that the Brush system was being adopted. The Post Office and the Arcade now employed it.

Lieut.-General H. MEADE HAMILTON, C.B., seconded the motion, which was carried, and the proceedings then terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices June 7.		Business Done Week Ending June 7. Highest.	Lowest
Anglo-American	53,	53½	54½	53¼
Do. Preferred	85,	85½	86½	85
Do. Deferred	23,	23½	24⅛	23¼
Brazil Submarine	11½,	11¾	11⅝	11 7-16
Cuba	9,	9½	9¼	9
Do. Preference	16,	17	16¼	—
Direct Spanish	6¼,	6¾	6⅝	—
Do. Preference	15½,	16½	16¼	16¼
Direct United States Cable	12,	12½	12¼	12¼
Eastern Telegraph	10¼,	10⅜	10⅝	10¼
Do. 6 per Cent. Preference	13,	13¼	13¼	13
Do. 5 per Cent. Debentures, 1899	102,	107	—	—
Eastern Extension	11¼,	11¾	11 11-16	11½
German Union	9½,	10	9¾	—
Globe Telegraph and Trust Company	6⅝,	6½	6⅝	6¾
Do. Preference	12⅛,	12⅜	12⅜	12¼
Great Northern	12¾,	13¼	13¼	12¾
Indo-European	28,	29	—	—
Mediterranean Extension	2,	2½	—	—
Do. Preference	8½,	9	8¾	—
Reuter's	12¾,	13¼	—	—
Submarine	265,	275	—	—
West India and Panama	1¾,	2	1 13-16	—
Do. 1st Preference	8¼,	8¾	—	—
Western Brazilian	7⅜	7⅝	7¾	7½
West. Union 7 per Cent. 1st Mortgage	121,	126	—	—
Do. 6 per Cent. Sterling Bonds	102,	105	105	—

TELEPHONES.

Consol. Telephone and Maintenance	1 11-16,	13-16	2	1⅝
Oriental	½,	⅝	11-16	½
United Telephone	14½,	14¾	15¼	14¼

ELECTRIC LIGHT.

Electric Light and Power	1,	1⅛	1⅛	15-16
Anglo-American Brush (£4 paid)	20,	20½	22¾	20
Eastern Electric	4⅜,	4⅝	4⅞	4½

TRAFFIC RECEIPTS FOR MAY, 1882.

Companies.	May, 1882.	May, 1881.	Incrse.	Decrse.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	—	—	—	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	33,087	29,523	3,564	—
Eastern Telegraph Company	—	—	—	—
Great Northern Telegraph Company	21,720	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

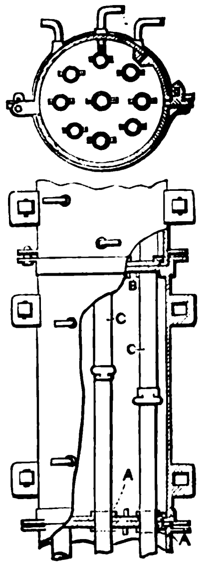
2704. IMPROVEMENTS CONNECTED WITH ELECTRIC APPLIANCES FOR MOVING AND OTHERWISE OPERATING UPON TRAMS, &c., *J Richardson, Lincoln.—20th June*, 1881.—(*Not proceeded with.*) 2*d.*

This invention consists in utilising an electric motor and secondary batteries to drive the tram car.

3790. IMPROVEMENTS IN AND RELATING TO THE COVERING, PROTECTION, AND INSULATION OF ELECTRICAL CONDUCTORS OR CABLES FOR TELEGRAPHIC, TELEPHONIC, AND OTHER PURPOSES, *W. R. Lake, London.—(A communication from S. D. Strohm, Philadelphia, U.S.)—31st August*, 1881. 6*d.*

The figure shows a section and a plan partly in section of the invention. The exterior casing is in two sections with external flanges, by which they are bolted together. The top section forms a movable cap, which facilitates inspection of the interior. Each cylinder has discs B, either forming a complete circle, or in sections as A A. These discs have annular grooves, into which the flanges of the sections of dies fit. They also

3790



have numerous openings for the passage of the tubes holding the wires. These tubes C C are formed in sections, and so constructed as to fit into one another; they are lined with insulating material and the wires laid inside. Modifications of this plan are also described by the inventor, whereby the joints are protected from moisture, &c., by india rubber rings, and fluid shellac is injected into the tubes and allowed to harden.

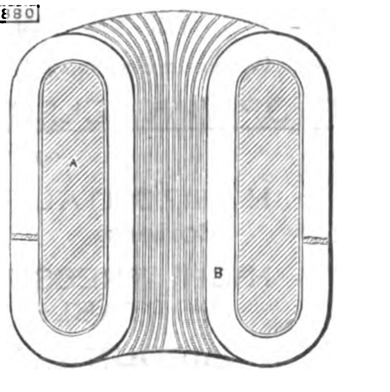
2770. IMPROVEMENTS IN ELECTRICAL RESISTING MEDIUMS, MORE PARTICULARLY ADAPTED FOR USE IN VACUUM AND OTHER ELECTRIC LAMPS AND TUBES, *R. H. Courtenay, London.—24th June*, 1881.—(*Not proceeded with.*) 2*d.*

This consists in preparing the carbon by first rubbing into the fibres of a skein of several threads of silk saccharine matter, such as date fruit, after which it is rubbed with a compound of plumbago, saccharine matter, and asbestos, to render it hard and smooth. The silk and compound are then gently heated. The inventor uses a compound of asbestos and fireclay as an insulator.

3880. IMPROVEMENTS IN THE MANUFACTURE OF REVOLVING ARMATURES AND OTHER PARTS OF ELECTRICAL APPARATUS AND IN MACHINERY THEREFOR, *W. R. Lake, London, 7th September*, 1881.—(*A communication from C. Dion, New York.*) 10*d.*

The figure shows the method of constructing the armature. The wire is ribbon shaped, and is placed in parallel coils around the walls of the armature in the following way—viz.: The outer portion of each coil is placed edgewise upon the outer surface of the core, the inner portion being arranged in the same way on the inner surface. The coils are insulated by being coated with gelatine treated with bichromate of potash, after which they are exposed to the light, whereby an insoluble film is produced. A is the core and B the wire. The core is made in two halves, upon which the wire, having been previously bent to the shape required to fit the coils by a special machine described in this specification and also

3880



the subject of this patent, is slipped, and the two halves are subsequently bolted together. The inventor claims that his system dispenses with commutators, as brushes can be applied direct to the conducting coils, one brush at the outside of the coils, and the other on a collector fitted on the axle of the armature. The coils also offer a small resistance as they have a large surface, and the risks of heating are reduced owing to the large cooling surface.

4069. IMPROVEMENTS IN AND RELATING TO INDICATING APPARATUS OR SIGNALS FOR RAILWAY SWITCHES OR POINTS, *W. P. Thompson, Liverpool and London.—21st September*, 1881.—(*A communication from W. W. Garz, Boston, U.S.*) 6*d.*

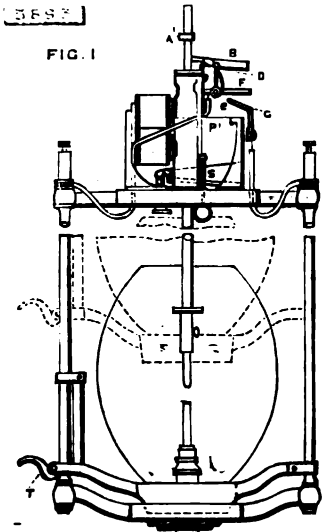
The object of this invention is to give advancing trains notice of the position of points whilst the trains are still distant from them, and is carried out as follows:—A switch, a magneto-electric generator, and a signal are so combined that the movement of the switch will cause the generator to actuate the signal.

3893. IMPROVEMENTS IN ELECTRIC LIGHTING APPARATUS, *W. R. Lake, London.—8th September*, 1881.—(*A communication from W. S. Hill, Boston, U.S.*) 8*d.*

This invention relates to improvements whereby a lamp may be automatically extinguished when the carbons are burnt low enough without affecting the other lamps in circuit; also to a means

3893

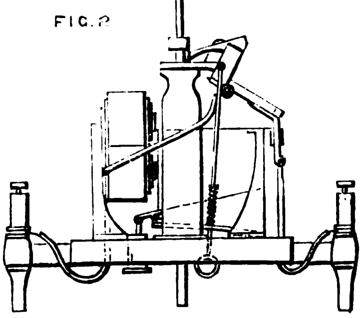
FIG. I



for lifting the glass globe, so that the carbons may be replenished from beneath without removing the globe. The figure shows the improvements as adapted to a Weston lamp, though they are applicable to other kinds of lamps. Supposing the arc to be formed the collar A^1, Fig. 1, is placed at such a point that when the carbons have burned as low as desired it will strike and depress inner end of lever B, causing it to release plate D, when the action of spring S moves the switch bar F to position shown in Fig. 2, or into closed contact with plate G, thereby offering a more direct passage for the current and diverting it from the regulating mechanism and carbons. The lamp having been supplied with new carbon; it can be put in action by drawing down rod P^1. To

3893

FIG. 2



replenish the carbons the globe is raised by sliding its holder up the side rods, the cam lever T by bearing against the left hand rod, holding it securely where desired. Another part of the patent refers to a means for automatically lighting the second of a double set of carbons when the first are consumed.

255,305. ELECTRIC LAMP. *Hiram S. Maxim, Brooklyn, assignor to the United States Electric Lighting Company, New York, N.Y.—Filed August 4th*, 1881.

Claim.—In an electric lamp, a frame of magnetic metal supporting the feed-regulating mechanism, the sides of said frame being provided with pole pieces and wound with an insulated conductor forming part of the lamp circuit, substantially in the manner set forth, to form the feed-regulating magnets. The combination, in an electric lamp, of parallel cores, having consequent poles and coils included in the main or arc circuit, armature, pivotted between the said poles and having coils forming part of a shunt about

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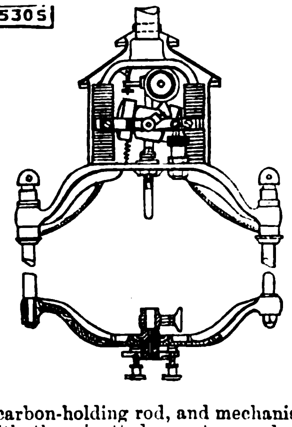

the lamp carbon-holding rod, and mechanism connected with the pivotted armature and adapted to control the descent of the carbon holder, as set forth. The combination of pivotted armature, link, and frame, having shafts carrying friction wheels journalled therein, which are adapted to engage with the carbon holder, one of said shafts being provided with a friction disc whose rotation is controlled by a detent carried by the armature, substantially as set forth. The combination, in an electric lamp, with a carbon-holding rod, of a cut out or switch consisting of a pivotted contact lever and insulated terminals, and a spiral spring connected to the lever at a point directly above the fulcrum, as and for the purposes set forth.

4421. APPARATUS FOR USE UPON TELEPHONE LINES, *G. Pitt, Sutton.—11th October*, 1881.—(*A communication from C. E. Buell.*) 10*d.*

The design of the apparatus is to signal to one of several stations upon the same telephone line without producing a signal at the others. The invention also relates to the arrangement of lines, and the apparatus at the central station. The details are exceedingly numerous, and relate to no less than twenty-seven claims.

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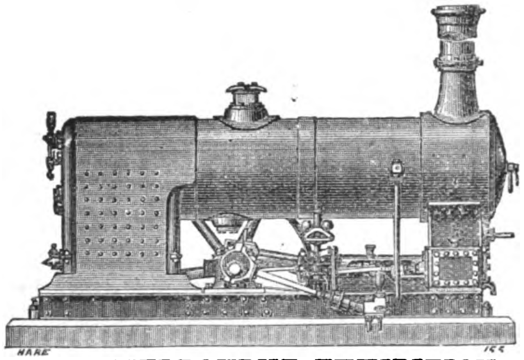

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THE EXCHANGE TELEGRAPH COMPANY, LIMITED.

Head Offices--17 & 18, Cornhill, E.C.; Stock Exchange, E.C.; 27, Regent Street, W.

Incorporated the 28th March, 1872, under the Companies Acts of 1862 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

Not having any springs or clockwork to wind up or to depend on, these instruments are acknowledged by those familiar with the system of telegraphy to be the only instruments yet invented that are capable of doing the work required of them continuously for a lengthened period, as evidenced by the fact that the Gold and Stock Company of New York, having the monopoly of this kind of business in the States, and which owns all the patents of the day of any value, has, after due trial, discarded all others.

The Company is prepared to treat with provincial Companies requiring instruments for the delivery of news for either single or double wire systems under the Company's patents, whereby from central stations identical information can be simultaneously delivered to any number of recipients by automatic, self-adjusting, printing instruments requiring no local batteries, no winding up, and no knowledge of telegraphy on the part of the receiver, the printing being in bold roman type, and the propulsion of the paper being effected by the electricity supplied from the Central Office.

The instruments supplied by the Company can be had to work either on single or double wires, and to print either on a slip or tape of paper, as has hitherto been the custom, or on a broad band of paper in column form.

LIFE ASSOCIATION of SCOTLAND.
Founded 1838.
HEALTHY PERSONS OF ALL AGES will find in the BONUS SYSTEMS of the LIFE ASSOCIATION of SCOTLAND advantages far exceeding those which can be obtained under any of the ordinary systems.

Claims and Bonuses paid	£4,028,000
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Immediate Entrants in Class A will secure ONE YEAR'S BONUS MORE THAN LATER ASSURERS in that class.
LONDON—5, Lombard-street, and 48, Pall Mall.
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CITY and GUILDS of LONDON TECHNICAL COLLEGE, COWPER-STREET, FINSBURY, E.C.—WANTED, an ASSISTANT in the PHYSICAL LABORATORY. One with a practical knowledge of dynamo-machines preferred. Apply in writing, sending testimonials, salary expected, &c., to Professor AYRTON.

WANTED, a PRIVATE SECRETARY.—Business habits, a good knowledge of shorthand, and some acquaintance with physics essential. Apply in writing, sending testimonials, salary expected, &c., to Professor AYRTON, 68, Sloane-street, S.W.

TO ELECTRIC LIGHTING COMPANIES or CAPITALISTS.
WANTED, ASSISTANCE to carry out final experiments upon an entirely new form of Secondary Battery—not copying in any way any patent now before the public. The expense would not be great to a Company, owing to the conditions which would be made. It is believed from present experience that it would be the best accumulator yet produced (not patented). Any Company or Capitalist rendering assistance would have right to the same on very reasonable terms.
Address, ACCUMULATOR, office of this paper.

JUNIOR DRAUGHTSMAN REQUIRED for Electric Light Machinery. One accustomed to Locomotive or Machine tools preferred. Apply, between 10 and 12 a.m. only, R. E. CROMPTON, 4, Mansion House-buildings, Queen Victoria-street.

A PRACTICAL ENGINEER and ELECTRICIAN (Assoc.Mem.I.C.E.) wishes an ENGAGEMENT. Accustomed to both Lighting and Manufacture. Highest references and testimonials.—Address, "D. E. R.," ELECTRICIAN Office.

ELECTRICAL BUSINESS for SALE, with STOCK and PLANT and new ELECTRIC LIGHT APPARATUS. Apply by letter first, "B. J.," 518, Oxford-street.

SMALL GRAMME MACHINE, A type. Almost new. 6,000 candles. To be SOLD. Apply, SYDNEY B. HODGE and SONS, Field-gate-street, E.

ELECTRICITY.—WANTED, by a Mechanical Engineer, SITUATION with Electric Light Company as UNDER MANAGER or DRAUGHTSMAN. No objection to travel.—G. H., 23, Temple-row, Birmingham.

A YOUNG MAN with capital is desirous of meeting with an opening leading eventually to a PARTNERSHIP in a well-established firm of Telegraph or Electric Engineers.—Apply, by letter only, to H., care of Messrs. Ingle, Cooper, and Holmes, City Bank Chambers, Threadneedle-street, E.C.

INSULATED ELECTRICAL WIRE, Silk, Cotton, or India-rubber covered. Conductivity guaranteed. German Silver Wires for Resistance. Braided Handle Cord, Silk Cord for Electric Bells, &c.—WILLIAM RICKARD, Derby. London Agent (stock kept), EDWIN HOLLOWAY, 2, Gutter-lane, E.C.

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SLIP

DIVIDEND.—The directors of the Eastern Extension, Australasia, and China Telegraph Company have declared an interim dividend for the quarter ended the 31st of March last of 2s. 6d. per share, or at the rate of 5 per cent. per annum, payable on the 15th prox.

THE RIOT AT ALEXANDRIA.—It is stated that the two Manchester men, Mr. Robert J. Dobson and Mr. Reginald J. Richardson, who were killed in the riots last Sunday, met their death while attempting to save some of the staff of the Eastern Telegraph Company who were in peril.

ELECTRIC LIGHT FOR CANALS.—It is stated that electric lights are being erected along a portion of the Surrey Canal, and it is probable that the whole length will eventually be lighted by the same means. This canal runs through the South East District of London to the Docks.

ELECTRIC LIGHT AT HARWICH.—It is stated that the South Eastern "Brush" Electric Light and Power Company have received orders from the Great Eastern Railway Company for lighting their works at Parkeston Bay, near Harwich, which will be carried out during the present month.

THE TELEPHONE IN CEYLON.—The latest news from Ceylon states that the electrician of the Oriental Telephone Company is in Colombo arranging for the erection of wires, and an experimental exhibition is soon to take place. The *Ceylon Observer* believes the system will become very widely adopted.

WHEATSTONE'S AUTOMATIC SYSTEM IN AMERICA.—The *Operator* says that the Western Union Telegraph Company is preparing to use the Wheatstone automatic system, so extensively employed in Europe, especially for sending Press reports. A number of operators are practising punching and slip reading.

ROYAL HORTICULTURAL SOCIETY.—This society gave its annual *fête* in the Gardens at South Kensington on Tuesday evening. The corridors round the Gardens were lit by Messrs. Siemens' electric lamps; the Gülcher Electric Light Company lighted up the great conservatory with their lamps; whilst the Brush Company lighted the ante-garden.

CENTRAL AND SOUTH AMERICAN CABLE.—The India Rubber, Gutta Percha, and Telegraph Works Company have received a telegram, announcing that the ss. "G. E. Wood" has completed the laying of her cable, and is now on her way home, and that the ss. "International" has landed the shore end at Galveston. All well on board.

TELEGRAPH INSTRUMENTS, &c., WANTED.—The Highland Railway Company are inviting tenders for the usual annual supply of wire, telegraph instruments and fittings, &c. Forms of tender may be obtained of Mr. J. G. Bulmer, storekeeper, Inverness. Tenders are to be sent to Mr. A. Dougall, secretary, at the company's office, in Inverness, addressed to the Directors, by the 24th instant.

EXHIBITION AT FALMOUTH.—This being the jubilee year of the Royal Cornwall Polytechnic Society, it has been resolved to hold an exhibition at Falmouth in commemoration of the event. The Exhibition will be held in the Polytechnic Hall and the Volunteer Drill Hall, and is to be opened on the 5th September. Electricity and electric lighting will form a prominent feature of the Exhibition.

A NEW USE FOR ELECTRIC LIGHTS.—A Cleveland (Ohio) paper of recent date says:—"On Thursday evening at 10 o'clock a flock of wild ducks in their flight over this city were attracted by the brilliant glare of the electric light on the Bank-street mast, and several of the birds flew directly against the lamps, shattering three of the glass globes and bringing down three good fat ducks, which were triumphantly carried away by passers-by."

ELECTRIC LIGHTING FOR THE NAVY.—A special committee, consisting of Captain Eardley Wilmot and Mr. J. Farquharson, of the Admiralty; Captain Gordon, of the "Vernon;" and Mr. Owen and Mr. Newman, Chief Constructor and Chief Engineer of the Dockyard, is conducting an exhaustive inquiry at Portsmouth into the merits of various systems for the electric lighting of ships of war. The inquiry is confined to the use of incandescent lamps.

SEVERE THUNDERSTORM.—A severe thunderstorm visited King's Lynn, in Norfolk, on the 13th inst. It is reported that at Massingham, twelve miles distant, the Abbey Farmhouse was struck by lightning and entirely destroyed. At Terrington St. John, seven miles west of King's Lynn, twelve houses were injured. Thirteen horses and 36 sheep are stated to have been killed at Watlington. No loss of human life appears to have taken place, however.

TELEGRAPH STORES WANTED.—Tenders are invited for the supply of 336 tons of galvanised annealed iron telegraph wire, 35,000 porcelain insulators, 35,000 galvanised iron insulator brackets, 80,000 galvanised square-headed iron wood screws. Particulars may be obtained at the Ministry of Posts and Telegraphs (Direction du Materiel et de la Construction), Rue de Grenelle Saint Germain 103, Paris, where tenders will be received up to the 20th instant.

THE TELEPHONE IN SHEFFIELD.—The Sheffield correspondent of the *Engineer* says:—"The Sheffield Telephone Exchange makes very rapid progress, thanks in a large measure to the attention given to it by the managers, Messrs. Tasker, Sons, and Co., Angel-street. On the 24th of May, I am informed, there were 240 messages sent in one hour, between 10 and 11 o'clock. The day's return was 1,294. The following day (Thursday) there were 1,290 messages. These are the two highest days on record."

ANGLO-AUSTRIAN BRUSH ELECTRICAL COMPANY.—The prospectus of this Company has just been issued. It has a capital of £500,000, of which £300,000 will first be issued in £5 shares. The Company has been formed to work the patents of Mr. Brush and Mr. Lane-Fox in Austria and Hungary. Copies of the prospectus, &c., can be seen at the offices of the solicitors, Messrs. Hollams, Son, and Coward, Mincing-lane, E.C. The secretary, *pro tem.*, is Mr. Miall Fraser, 4, Copthall-buildings, Bank, E.C., and Mr. C. H. Benton will act as electrician.

LIST OF CABLES INTERRUPTED.—The following is a list of the telegraph cables at present interrupted:—St. Thomas and St. Kitts, St. Vincent and Grenada, Guadeloupe and Dominica, and the Paris and New York Telegraph Company's cable.—South America: The cable between Rio Grande do Sul and Monte Video is interrupted.—West Indies: The cables between St. Thomas and St. Kitts, and between St. Vincent aud Grenada are interrupted; and there is, therefore, no telegraphic communication with the Island of St. Kitts, Antigua, Guadeloupe, Dominica, Martinique, S. Lucia, St. Vincent, and Barbadoes.

NEW COMPANY.—The prospectus of Edison's Indian and Colonial Electric Company (Limited) has been issued. The company has been formed to work Edison's inventions in India, Ceylon, Australasia, and South Africa, it also has the sole right to use in those countries any improvements which

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Edison may introduce in his apparatus during the next five years. The capital is £250,000, in 40,000 "A" shares and 10,000 "B" shares of £5 each; 5,000 "A" shares; and all the "B" shares are taken as part of the purchase money. The "B" shares will receive no dividend until the "A" shares have received a cumulative dividend of 6 per cent.; 35,000 "A" shares are offered to the public.

Long Distance Telephoning.—Recent experiments have been made with M. van Rysselberghe's system of telephony, during which a message was sent by telephone over a long distance at the same time that a telegraphic message was traversing the same wire. The first experiment was made on an ordinary telegraph wire 353 kilometres long, between the railway station at Paris and that at Nancy. The second was made between Paris and Brussels, over a wire 344 kilometres long. It is stated that the telephonic message was distinctly heard, whilst the telegraphic message was distinctly rendered by the Morse instruments employed, although both were sent at the same time and along the same wire. M. van Rysselberghe is well known as the head of the Meteorological Observatory at Brussels, and an ingenious electrician.

The Disintegration of Electrodes.—According to an article by Messrs. Reitlinger and Wächter in the *Ann. Phys. Chem.*, the discharge of positive electricity is the sole cause of the electrical disintegration which occurs at the surfaces of flat, spherical, or pointed metallic electrodes. The authors have ascertained that whenever negative electricity traverses a resinous surface, it always leaves traces of a circular spreading, whilst positive electricity can, according to circumstances, occur either in radial lines, or in circular discs or rings. An inversion of Lichtenberg's figures, by means of which negative electricity would give a radiating figure, is found to be impossible down to the smallest lines or rays. The positive Lichtenberg radiating figures are caused by minute particles detached from the electrode, whilst the positive as well as the negative disciform figures are produced by gaseous discharges.

Self-Generating Electric Light and Power Company.— In explanation of the title "Self-Generating," assumed by this recently floated company, the secretary writes, "that the title 'Self-Generating,' in the absence of any other sufficiently concise term, was selected to distinguish this company as independent of any external motive-power and machinery in the production of its light, each separate establishment having, therefore, self-generating apparatus for its light. The patentee claims to effect this result by a method of constructing and charging batteries for the production of electricity sufficiently cheap, and capable of lasting sufficiently long, to bring this method within the region of practical operation." We shall not endeavour to give any opinion upon the manner in which this company was brought before the public; but this we do know, that there is no battery in existence at present capable of competing economically with dynamo machines to supply light and power.

Effects of Currents on Magnetised Electrolytes. —In a recent number of the *Proceedings of the Royal Society* Mr. G. Gore treats of certain electro-magnetic rotations produced in liquids by means of axial electric currents, either in the interior of vertical magnets, electro or permanent, or near their poles, which differ from rotations previously described by the absence of radial currents. According to the author a column of an electrolyte enclosed in an electro magnetic helix is twisted in a similar manner to an iron wire or rod placed under similar conditions. The rotations produced in liquids are strongest at the poles and a little distance beyond them, and *nil* at the centre. The rotations within the tube and to a short distance beyond are opposite to those produced by a voltaic solenoid; a magnet tube has then three points of rotation with an axial current, one at its centre and one near each end, whilst a solenoid has only the former. These phenomena are more definite and powerful with a tubular electro-magnet than with a voltaic current alone.

Electric Light on the Embankment.—The following is from the report of the Metropolitan Board of Works for 1881, which has just been issued:—"The Victoria Embankment and Waterloo Bridge continue to be lighted by electricity, according to the method devised by M. Jablochkoff. There are forty lights on the Embankment wall and ten on Waterloo Bridge. The lighting is undertaken by the same French company as originally introduced the system into London. When the company first began to charge for the light at so much an hour for each lamp the rate agreed upon was 5d. an hour. At the end of three months the price was reduced to 3d. on condition that this should continue for six months, and, at the end of that time, the company made a further reduction in the price, agreeing to continue the light for one year, at the rate of 2½d. per light per hour. This last agreement was made in April, 1880, and continued until June, 1881, when a fresh agreement was made with the company to continue the lighting for a term of three years from that date, at the rate of 1½d. per light per hour.

The Electric Light Bill.—The Select Committee on this Bill met on Monday for the further consideration of the clauses of this Bill. The committee consulted in private to consider the proposal made by Mr. Wright, Q.C., on behalf of the gas corporations, and subsequently announced their decision. They decided to insert a clause empowering any local authority, company, or person who had obtained a license, to contract with any company or person for the execution and maintenance of any works required for the supply of electricity, but providing that no local authority, company, or person should by any contract transfer to any other body, or divest themselves of any powers given to them, or legal liabilities placed upon them by the Act. The remaining clauses of the Bill having been passed, the committee rose. It was expected that they would bring up their report on Thursday last. The *Standard* hears that the Bill is threatened with considerable opposition. The electric companies hold that the monopoly of fifteen years which the Bill proposes to give is too short, and intend to make an effort to get it extended to twenty-one or twenty-five years.

The Edison Lighting Station in New York.—The latest account of the progress that has been made in laying mains, &c., for the New York lighting station of the Edison Company states that, prior to the 1st April, a little over 55,000 feet of street underground conductors had been laid, including mains on the block fronts, street intersections, and feeders. The work of laying intersection safety catch boxes was begun experimentally in March, but only one box was actually laid in that month. The next month thirteen were put in. The total amount of mains laid during April was 12,500 feet, making about 67,700 feet of conductors already put in the ground. On the 1st May there yet remained to be laid about 14,300 feet, including not only street mains, but also connections at street intersections, feeders, and some extra mains specially required, also forty-seven street intersection safety catch boxes, and forty-eight bridge safety catch boxes. These boxes were described and illustrated in the last volume of *The Electrician*. Three out of the six large dynamos that

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are eventually to be erected in the central station in Pearl-street are now being erected there. The others are ready and will follow as soon as the first three are in place.

ELECTRIC LIGHT FOR TORQUAY.—The question of the adoption of electric lighting came before the Torquay Local Board at their last meeting, when it was ultimately decided to let the matter remain for the present in abeyance, until the various systems had had a more extended trial. In the course of the discussion on the subject a Mr. Murray, member of the board, stated that when in London recently he "made inquiries into the matter, and was shown [we quote from a local contemporary] a report of the practical working of the electric light at one of the large railway stations for a period of nine months. An area was illuminated which would require 228 gas jets. Counting the gas at 3s. per 1,000 feet, there was a small balance against the working of the electric light of £7 and a few shillings on the nine months' working. With respect to the gas at Torquay, for which the town was paying 3s. 9d. per thousand feet, a saving under similar circumstances would be effected of something like £100 a year. It was most important that the town should acquire its own lighting. They saw the result of an opposite policy in the 7 and 10 per cent. which was now going into the pockets of the shareholders of the gas company, and which should have gone towards diminishing the rates, a course of action which he took to be one of the especial functions of such a body as that board."

COLONIAL EXHIBITION AT AMSTERDAM IN 1883.—The preparations are being actively pursued for an exhibition of a decidedly novel character to be held next year in the Dutch capital. The primary idea is, by showing the indigenous produce of the colonies of the various European states side by side with the articles most suitable for exportation, to favour and incite a judicious and more active interchange. In Group III., devoted to Europeans in their relations with the native inhabitants of the colonies, Class 18 relates to telegraphs, postal service, and telephones, with appliances, models, and drawings. In Group VII., machines, tools, and means of transport, Class 43 includes plant and apparatus connected with electricity, telegraphs, and telephones. Exhibitors are invited to send in reports, statistics, and treatises on all the subjects included in the programmes, and generally on all questions affecting exportation. The Exhibition is under the patronage of the King of Holland and the Dutch Government, and under the honorary presidency of the Colonial Minister. The president is M. J. Léonard Wolterbeek; the secretary, M. Th. Stuart; and the general commissioner, M. E. Agostini; while the president of the Executive Council is M. D. Cordes, with M. J. Kappeyne Van de Coppello as secretary. The Exhibition is to open on the 1st May next, and to remain open at least five months.

THE GAS INSTITUTE.—The nineteenth annual meeting of the Gas Institute was held on Tuesday at the Institution of Civil Engineers. Mr. G. W. Stevenson, the president, in his inaugural address, observed that they honestly believed that they had the best artificial light for general purposes, and they would, therefore, be false to themselves if they did not take infinite pains to demonstrate to others the advantages of this light over that of tallow, oil, petroleum, or electricity. The electric light had come on them not as a novelty, but as a somewhat more practical competitor, and in proportion as its promoters were successful in improving and cheapening it, it would become formidable as a competitor with gas for the lighting of streets and dwellings. At present, however, they had nothing to fear from it, but its very presence among them ought to stir them up to maintain the supremacy they held. He said the proposals of the Electric Lighting Committee showed how the Board of Trade was gradually seeking to arrogate to itself the powers hitherto somewhat jealously guarded by Parliament. If these proposals were adopted, especially the granting of licenses permitting promoters to break up the streets to supply electricity in competition with gas, the *quasi* monopoly of gas companies would be placed on the same footing as the chances of an omnibus proprietor, who is liable at any moment to have his business interfered with by a tramway company.

TELEGRAPH CLERKS GRIEVANCES.—A letter appeared in *The Times* of June 15, in answer to Mr. Fawcett's letter to Mr. Macliver, which we gave extracts from in a recent issue. The writer, who signs himself "Metropolitan," says:—"Last year the telegraphists urged upon the Postmaster-General the desirability of abolishing classification, but most unfortunately without avail. It can now be seen how baneful are the results of a system which has received new life at the hands of the Postmaster-General. The old third-class maximum was £65 per annum, at which stage numbers of men stood still for years. That class was recently abolished, and the maximum of the lowest class was made £100 per annum. At the same time the next class was extended, and promotions to it were given to as many clerks as were necessary to fill up the new vacancies. In this way three clerks in the London districts were promoted from £65 to £110 per annum, but, at the same time, only a £5 increment was given to others who had been in the service equally long, and for whom there is now a weary five years of toil before they will reach the maximum of their present class, which is only £100 per annum. Now, had classification been abolished, instead of larger increments being given to some than were necessary to place them in their proper positions, we should have had the money which was voted by Parliament last year more justly distributed, and, without any additional cost to the country, we should have seen no such cases of inequality as a £45 increment being given to one clerk and only £5 to another with an equal claim."

TELEGRAPHS IN NEW SOUTH WALES.—The growth of the telegraph in this Australasian colony is well shown by the following extract from a statistical and descriptive account of the colony, published annually by Mr. Thomas Richards, government printer:—"Telegraphs have been rapidly extended in New South Wales. The first line was opened on 26th January, 1858. The following figures record the growth of the telegraph department during the ten years 1871 to 1880: 1871, miles of wire, 5,579, 1880, 13,188; 1871, stations, 89, 1880, 289; 1871, messages, 218,530, 1880, 1,319,537; 1871, cost of construction, £195,245, 1880, £462,226; 1871, revenue, £32,665, 1880, £84,110. The length of telegraph wire is much greater in New South Wales than in any of the other Australian colonies, and bears favourable comparison with the extent of lines in older countries. Up to the end of 1881, there were 13,688 miles of telegraphic wire laid, and 328 stations. The revenue was £100,000. Nearly all the recent improvements have been adopted by the department, and its show of scientific apparatus at the recent International Exhibitions was of a complete and interesting character. Telegraphic lines are not only to be found in all the centres of population, but they have been extended to the most remote districts, and the scale of charges has been greatly reduced, which has caused the expenditure to exceed the revenue of late years. For one shilling a message of ten words can be sent to any station in the colony, and for two shillings to any part of the Australian Continent. Thanks to the enterprise of South Australia

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there is a line 1,800 miles long, from Adelaide to Port Darwin, which, connecting with the ocean cable, unites Australia with every part of the world."

On Rotary Polarisation by Chemical Substances under Magnetic Influence.—This was the title of a recent paper read before the Chemical Society by Mr. W. H. Perkin. The object of the author was to discover, if possible, whether any relationship existed between the chemical composition of substances and their power of rotating the plane of polarisation when under the influence of magnetism. The apparatus used was similar to that employed by Becquerel. The liquids being placed in the tubes closed at their ends with glass plates, the ends of the tubes were inserted a short distance into perforations in the armatures. Water and carbon disulphide were used as standards. The author's results, which were calculated for unit lengths of the fluids, agreed pretty closely with those of De La Rive and Becquerel, but seemed to bear no relationship to chemical composition. On consideration it seemed probable that unit lengths of vapours would give better results. It was soon apparent that the direct estimation would be attended with too many difficulties; the results of the observations obtained with unit lengths of fluids can, however, be referred to the lengths of columns of liquids which would be formed by the condensation of unit columns of their vapours, in other words to lengths related to each other in proportion to their molecular weight, making the necessary correction for difference of densities. This can be done by the simple equation $\frac{r \times m\,w}{d}$, r being the observed rotation, $m\,w$ the molecular weight, and d the density. Having made this calculation for the substance under examination and for the standard with which it is compared, the molecular co-efficient of magnetic rotation, or more briefly the molecular rotary power, can be obtained by dividing the former by the latter. The numbers thus calculated clearly indicate that the molecular magnetic rotary power follows the chemical composition.

Indian Telegraphs.—According to the annual report of the Indian Telegraph Department for 1880-81 some slight changes were introduced during the year, reducing the number of free messages, and relieving the department of the charge of the lines in Ceylon, which were re-transferred to the Ceylon Government. The lines in Afghanistan were dismantled, new lines were added to existing supports, and other similar changes of an unimportant nature took place. The total miles of lines were 19,679, and of wires 54,433, besides 1,655 miles of wire maintained by the department for the service of railway companies. Messages increased in number from 1,562,511 in 1879-80 to 1,656,230, of which 297,753 were foreign and the rest inland. The surplus of earnings over working expense was 13,19, 363 rs., the same as in the previous year, the working expenses being about 32 lacs, and the earnings 45 lacs. Although the number of messages has increased, the average time occupied in their transmission along the main routes has decreased. The average time taken to send messages from Calcutta to Bombay was one hour and six minutes, to Madras one hour and fourteen minutes, to Rangoon two hours and nine minutes. The following is an analysis of the complaints made during the year:—For non-delivery 140, for delay 56, for error 121, miscellaneous 5. This shows a slight improvement on the previous year. There were also 5,250 undelivered messages, mostly due to insufficient or incorrect addresses. The interruptions which occurred on different lines owing to heavy floods during the monsoon were neither numerous nor long, and the worst appears to have been one caused by landslips at Naini Tal, which lasted 328 hours. Among some of the principal extensions mentioned as having taken place is a second wire for forty miles added to the Moulmein-Amherst line, and carried on to Tavoy; a new three wire line, 136 miles in length, constructed along the Holkar Sindia-Neemuch State Railway, and a line, forty miles in length, from Dera Ismail Khan to Tonk. The report states that telephones were put up to connect several of the Government offices at Simla, and were also used during the siege of Candahar in August, 1880.

Electric Lighting in Hull.—The *Eastern Morning News* of recent date contains the following account of the progress made by Messrs. Siemens Brothers in the erection of their lights at Hull. It will be remembered that this firm lately contracted with the Corporation to erect and maintain their lights in portions of the Old Town and Town Hall for twelve months. It is hoped that the lighting may be begun early in July. Our contemporary says:—"The streets will be lighted by means of four large arc lamps, each of 3,000 candle-power, and 22 smaller arc lamps, of about 350 candle-power. The current for each of the large lamps will be generated by a separate machine, of the type known as the 'continuous current' machine. Each lamp will be placed in large alabaster globes, fitted with reflectors for diffusing and throwing down the rays of light, and suspended at a height of about 50ft., on the tubular standards erected at the bottom of Whitefriargate, the west end of Holy Trinity Church in the market-place, at the corner of Mytongate, and on the Victoria Pier. The 22 differential lamps will also be placed in alabaster globes, and at a height of 20ft. from the ground, on the posts now standing in the streets, and distributed as follows:—Lowgate, five; Market-place, three; Queen-street, three; Nelson-street, three; Victoria Pier, one; Silver-street, one; Whitefriargate, four; North and South Church-side, one each. These lamps will all be maintained by means of one machine of the 'alternating current' type, and arranged on two circuits of eleven lamps each. This machine is capable of maintaining 32 such lamps should extensions be found desirable. In the Town Hall five powerful arc lamps, of 1,000 candle-power each, maintained by one 'continuous current' machine, will be employed for lighting the entrance hall and the reception room; while in some of the smaller rooms and offices 50 incandescent lamps will be distributed. In the Council Chamber special arrangements will be made, by means of which it can be lighted at pleasure, either by means of one powerful arc light suspended in the centre of the room, or by 60 incandescent lamps attached to the existing gaseliers. The whole of the machines will be fixed in a shed in the yard of Messrs. King and Co., South Church-side, and driven by two 12 horse-power compound semi-portable engines. The current will be conveyed by means of copper conductors, carefully insulated with gutta percha, and laid in 6in. iron pipes, boxes being provided where necessary for connecting the mains with the various lamps. In order to make assurance doubly sure, and avoid any possible risk of fire, all the wires in the Town Hall will be covered with india rubber and tape, while each individual lamp will be provided with a safety-plug, so constructed as to fuse and immediately break the circuit should any undue heat occur. Every care and precaution has been taken to render this installation an unqualified success, and the experience of Messrs. Siemens, and the completeness of their system render failure almost an impossibility. The work in Hull is being done under the superintendence of Mr. W. W. Melhuish, engineer."

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THE PHENOMENA OF THE ELECTRIC DISCHARGE WITH 14,400 CHLORIDE OF SILVER CELLS.*

BY WARREN DE LA RUE, ESQ., F.R.S., SEC.R.I., ETC.

(CONTINUED FROM PAGE 80.)

Between discs the law of the electric discharge is not the same as between points; its length does not increase nearly so rapidly, as will be seen by a reference to the diagram (Fig. 7), which represents the discharge between two points, a point and disc, between spherical surfaces, and between concentric cylinders. But the increment of potential necessary to produce a discharge for a given distance between discs, say a centimetre, becomes less as the distance between discs, and consequently the potential, are increased. Thus, the electrostatic force per centimetre with 1,000 volts and a striking distance of 0·0205 centimetre, is 163 electrostatic units, while it is only 113 units with 11,000 volts and a striking distance of 0·3245 centimetre.

We have found, moreover, that the discharge between discs in air, hydrogen, carbonic acid, and probably also in other

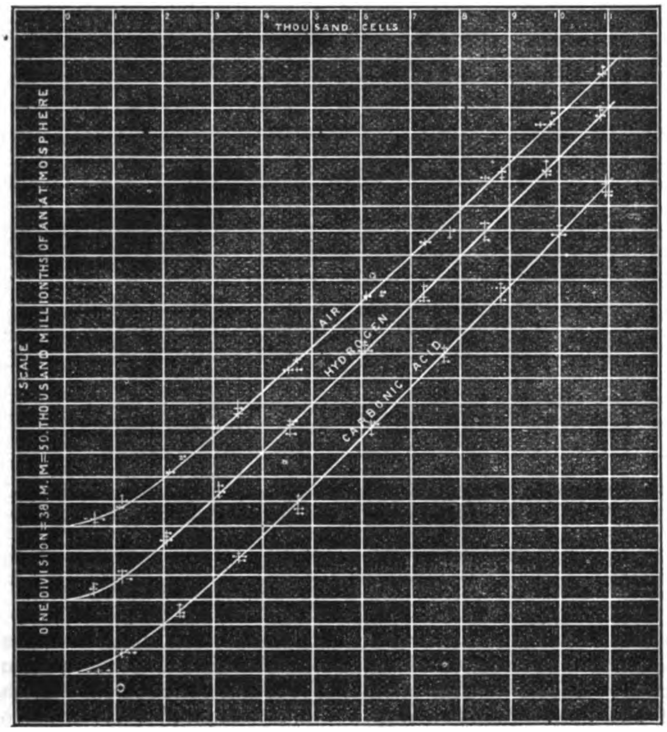

FIG. 8.

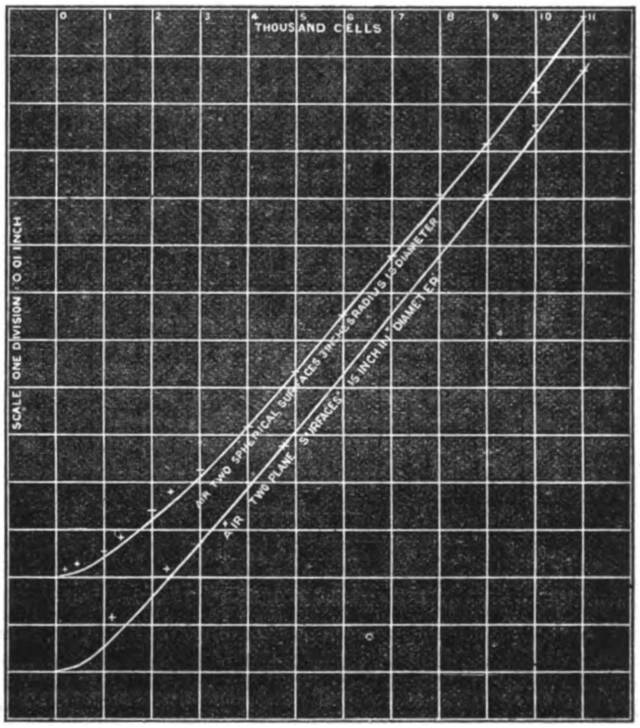

FIG. 9.

gases, may be represented by a hyperbolic curve, and this is the case whether we send the discharge through the gas at a constant pressure and increase the distances between the terminals and also the number of cells, or send the discharge at a constant distance and vary the pressure and number of cells; the obstacle in the way of a discharge being as the number of molecules between the terminals *up to a certain point*, as will be seen in the diagrams (Figs. 8 and 9), in which the cross marks represent the actual observations. For although the potential necessary to produce a discharge diminishes as the pressure decreases, yet this is true only up a certain limit; after this has been reached it rapidly increases, and ultimately the resistance becomes so great, as the exhaustion is carried further, that it is easier for a spark to pass between terminals placed at the same distance outside the tube in air at atmospheric pressure. The diagram, Fig. 10, in which the abscissæ are the cube roots of the pressures in millionths of an atmosphere, and the ordinates the number of cells necessary to produce a discharge in a hydrogen tube 30in. between the terminals, shows the results of experiment. The pressure of minimum resistance varies for different gases. We have determined it to be 0·642 mm. = 845 millionths of an atmosphere for hydrogen, at which pressure the potential necessary to produce a discharge through a tube with terminals 30in. apart was found to be only 430 cells. At a pressure of 0·0065 mm., 8·6 millionths, it requires as high a potential, 8,937 cells, as at a pressure of 21·7 mm., 28,553 millionths, to cause the discharge to take place. At 0·00137 mm., 1·8 millionth, 11,000 cells, will not pass. The greatest exhaust we have obtained in a hydrogen vacuum and an absorption by spongy palladium was 0·000055 mm., 0·07 millionth, which offered so great a resistance that a 1-inch spark from an induction coil could not traverse the tube. I will now exemplify what I have said by showing you a tube with an absorption chamber (Fig. 11). I expect that the vacuum will prove to be so good that the whole of the battery, 14,400 cells, will not cause a current to pass. You see there is no illumination of the tube; if I now heat the absorbing material so as to cause gas to enter the tube, then the discharge of a much smaller number of cells—namely, 3,600, illuminates the tube, and if I allow it to cool again the discharge ceases.

It has been suggested that there is a polarisation of the terminals of a vacuum tube during the passage of electricity just like that which occurs in a voltameter, and that this increases the obstacle to the discharge; but by an elaborate series of experiments we have proved that such is not the case under the conditions of the experiment. It is quite true that, after the connection between the battery and the terminals of the tube has been broken, there is a deflection of the needle when they are connected with a galvanometer, but we have shown that this is entirely due to a minute static charge proportionate to the capacity of the terminals.

Our experiments enable us to throw some light on another atmospheric electrical phenomenon—namely, the probable height of the aurora borealis, which the accompanying figure (Fig. 12) of a discharge roughly resembles. I will now pass the current of the whole 14,400 cells through the large tube 199, containing a residual charge of atmospheric air at a pressure of one millimetre, and you will perceive a carmine luminosity touching the positive pole, and reaching half-way down the tube. This reminds one of those ruddy glows frequently seen in auroral displays. Fig. 12 in the plate is copied from a photograph since taken in my laboratory of this appearance. Around the bright luminosity is a dark band which shuts off a portion of the fluorescence of

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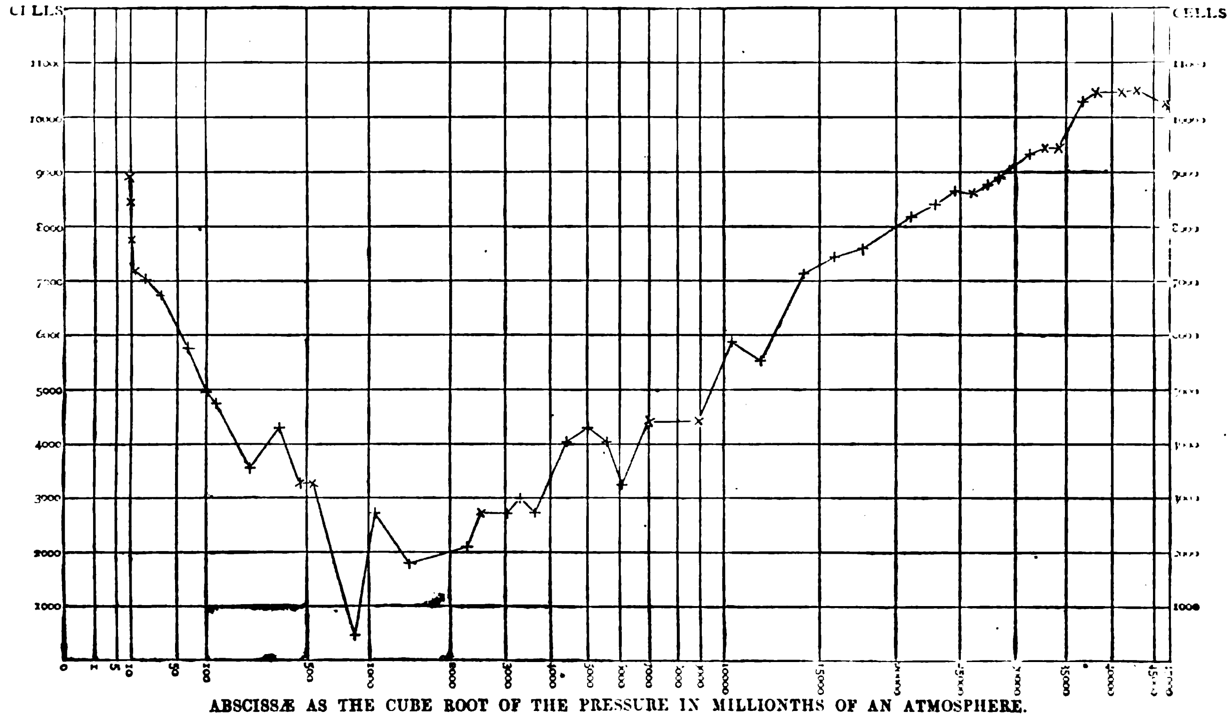
the glass tube, a blue fluorescence produced by the ruddy light of the luminosity, showing that around the luminosity there is an absorbent zone of less elevated temperature. Many estimates have been made from time to time of the height of auroræ, founded upon observations made by persons at a distance from each other, and supposed to be observing the same feature in the display; but it must be remarked that there is always much uncertainty in these estimates, from the difficulty of knowing whether the different observers have noticed the self-same streamer. Frequently very considerable altitudes have been assigned to these displays; for example, as much as 281 miles. We shall presently see that it is very improbable that any electrical discharge could occur at such a height. We have calculated from experiment that the pressure of least resistance for air is 0·397 millimetre, 498·6 millionths, and therefore in air it results that a maximum electric discharge, and consequent brilliancy, of the aurora, would occur at an elevation where the atmosphere has that pressure—namely, 37·67 miles. The greatest exhaust we have produced—and this has not been surpassed—is 0·000055 millimetre, 0·07 millionth, which is the pressure the atmosphere would have at 81·47 miles; and as 11,000 cells failed to produce a discharge even in hydrogen at this low pressure, it may be assumed that at this height the discharge would be considerably less brilliant than at 37·67 miles, should such occur.

At a height of 281 miles the atmosphere would only have a pressure of 0·0000000000000000000018 millimetre, or 0·000000000000000000024 millionth, and even at 124·15 miles in height the atmospheric pressure would be only 0·00000001 millimetre, or 0·00001 millionth. It is highly improbable that a display of aurora would occur at a height even of 124 miles, and it is difficult to conceive that an electrical potential could possibly exist necessary to overcome the enormous resistance that would be offered at 281 miles, the tenuity of the air being 54,000,000,000,000 (54 million million) times as great as at 124 miles.

Pressure mm.	Pressure M.	Height, miles.	Visible at miles.	Remarks.
0·00000001	0·000013	124·15	1061	No discharge could occur.
0·000055	0·07	81·47	860	Pale and faint.
0·379	499·0	37·67	585	Maximum brilliancy.
0·800	1053·0	33·96	555	Pale salmon.
1·000	1316·0	32·87	546	Salmon coloured.
1·500	1974·0	30·86	529	,, ,,
3·000	3947·0	27·42	499	Carmine.
20·660	27184·0	17·86	403	,,
62·000	81579·0	12·42	336	,,
118·700	156184·0	9·20	289	Full red.

There are some phenomena connected with the discharge from the voltaic battery which I will bring under notice before we proceed to the study of the discharge in vacuum tubes. I have already spoken of the difference in the length of the discharge between points and discs; and I have now to call your attention to the influence of the form of the point on the length of the spark. At first it would naturally be supposed that the longest discharge would occur with the sharpest point, but this is not the case; a great number of experiments with various forms of points have shown that a point in the form of a paraboloid gives the longest spark; and longer in the proportion 1·29 to 1 than one in the form of a cone of the same length and diameter at the base. It is difficult to account for this difference in the length of the spark, but it is evident the potential must be greater at the extremity of a parabolical point than it is at the extremity of a conical one (Fig. 13).

If a point and a disc be used together as terminals and the point be made alternately positive and negative, the spark is longest when the point is negative for low tensions



ABSCISSÆ AS THE CUBE ROOT OF THE PRESSURE IN MILLIONTHS OF AN ATMOSPHERE.

THE DISTANCES 0 TO 1, 0 TO 100, 0 TO 1000, &C., SHOW RELATIVELY THE NUMBER OF MOLECULES IN A GIVEN LINEAR SPACE.

FIG. 10.

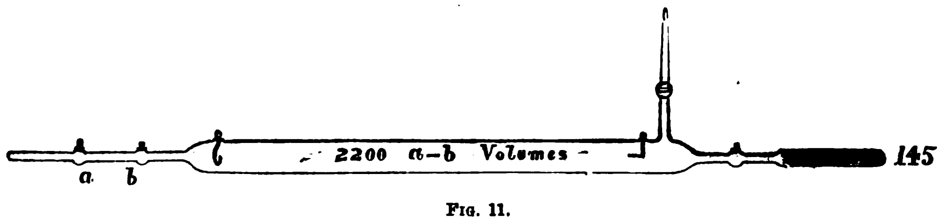


FIG. 11.

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up to 8,000 cells, and longest when the point is positive beyond that number.

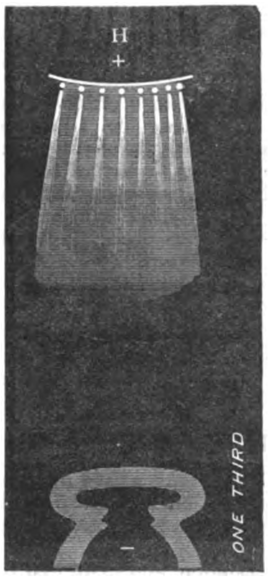

Fig. 12.

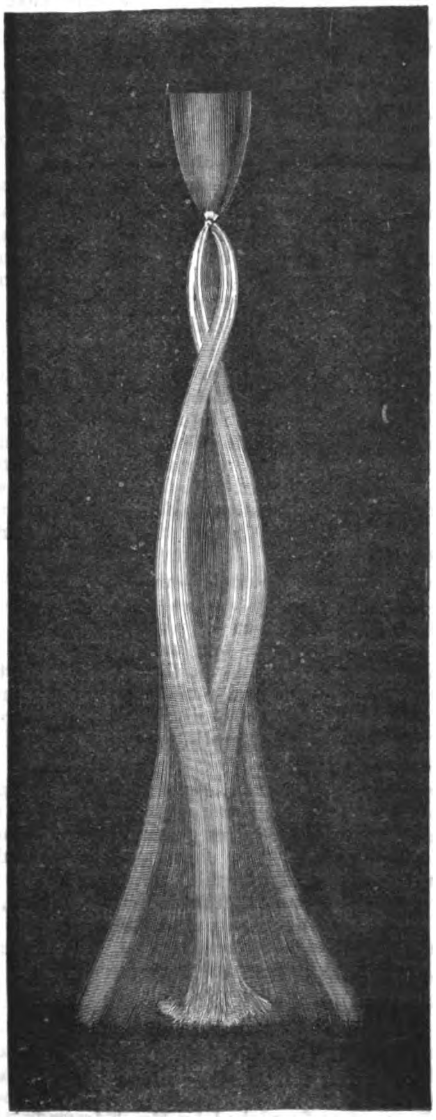

Fig. 14.

The nature of the metal makes not the slightest difference on the length of the spark, with one exception. Brass, copper, silver, steel, platinum, magnesium, and graphite, all give, under similar circumstances, precisely the same length of spark; aluminium, however, gives a spark longer in the proportion of five to four.

Before the spark jumps and the arc forms it is preceded by what we have called the streamer discharge. This is different in appearance at the positive and negative terminals. You

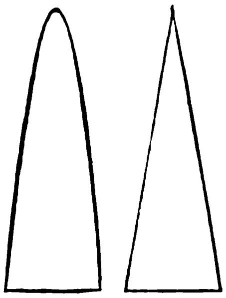

Fig. 13.

are not able to see the characteristics now that I produce the streamer discharge before you, but they are represented enlarged on the diagram, the terminals being supposed to be a point and a disc, and the point being made alternately positive and negative. When the point is positive the discharge takes the form of a series of twisted streamers (Fig. 14), when negative it is in the form of a brush (Fig. 15). The

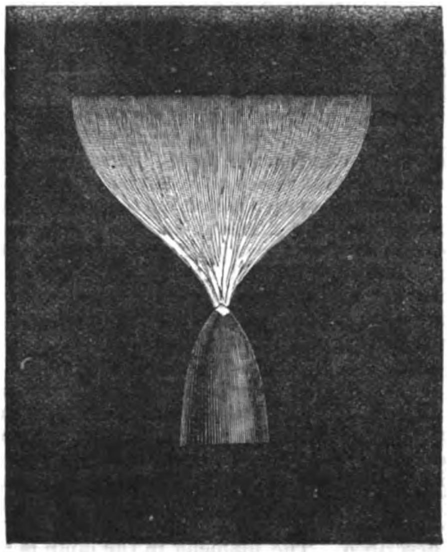

Fig. 15.

current which takes place in the form of streamers at a distance but a very little beyond the true striking distance—namely, that at which the arc is formed, is only the 1-2500th part of the current which passes with the arc, and this is only one half of that of the battery when short-circuited. When the streamer discharge is examined in a rotating mirror

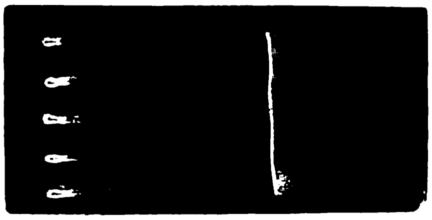

Fig. 16.

with a microscope suitably constructed, it is seen that the negative current is much the more continuous, for with the same velocity of the rotating mirror the positive discharge breaks up into a series of distinct images, whilst the light of the negative is spread out into a sheet, as you will see on the diagram (Fig. 16).

(TO BE CONTINUED.)

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REPORT ON THE INCANDESCENT LAMPS EXHIBITED AT THE INTERNATIONAL EXPOSITION OF ELECTRICITY, PARIS, 1881.*

I.—Description of the Lamps.

The only lamps in the Exhibition which were purely incandescent in character were those of Edison and Maxim, in the United States Section, and those of Swan and Lane-Fox, in that of Great Britain. The idea represented in these lamps is essentially the same in all of them, the differences being, for the most part, details of construction. They all consist of a glass envelope more or less spherical in form, in which is enclosed a carbon loop, made of carbonised organic material, and supported upon wires of platinum sealed into the glass. The space in the interior of the lamp is very perfectly exhausted.

A. *The Edison Lamp.*—The Edison lamp is pear-shaped in form. The carbon filament is long and fine, and is bent into the shape of a U. It is made from Japanese bamboo, cut to the requisite size in a gauge. In section it is nearly square, being about 0·3 millimetre on a side, the ends being left considerably wider. The fibre is carbonised in moulds of nickel, and is attached to the conducting wires by copper, electrolytically deposited upon them.

B. *The Swan Lamp.*—The Swan lamp is globular in form, the neck being quite long. The carbon filament is made from cotton thread, parchmentised before carbonisation by treatment with strong sulphuric acid. The ends of this filament are very much thickened, and the loop has a double turn at the top. Its ends are clamped in a pair of metal holders, supported laterally by a stem of glass which rises through the neck to the base of the globe. Below, these holders are fastened to wires of platinum which pass through the glass.

C. *The Maxim Lamp.*—The Maxim lamp is also globular in form, but it has a short neck. Within the neck rises a hollow cylinder of glass, supporting upon its summit a column of blue enamel, through which pass the conducting wires of platinum which carry the carbon. The filament is made from cardboard cut by a punch into the form of an M. In section, therefore, it is rectangular, and several times as broad as it is thick. It is carbonised in a mould through which a current of coal gas is passed. After carbonisation the filament is placed in an attenuated atmosphere of hydrocarbon vapour and heated by the current. The vapour is decomposed, and its carbon is precipitated upon the filament. In this way not only are inequalities obliterated, but the resistance of the filaments may be equalised, and brought to any standard required.

D. *The Lane-Fox Lamp.*—The Lane-Fox lamp is ovoid in shape, the neck being in length intermediate between the two lamps last described. The carbon is in the form of a horse-shoe, and is circular in cross-section. It is made from the root of an Italian grass, largely used in France for making brooms. After carbonisation the filaments are classified according to their resistances. They are then heated in an atmosphere of coal gas, by which carbon is deposited upon them, as in the filaments of the lamps last described. The filament in the lamp is supported by platinum wires, to which it is attached by sleeves of carbon encircling both. These wires pass through tubes in the top of a hollow glass stem. Just below the extremities of these tubes are two small bulbs containing mercury, forming the contact between the platinum wire sealed into the glass above and the copper conductor which enters from below. These conductors are held in place by plaster, which fills the base of the lamp.

II.—Methods of Measurement.

The question to be determined was simply the efficiency of these lamps. The efficiency of a lamp is the ratio of energy produced to energy consumed, *i.e.*, the quantity of light given by the lamp for each horse-power of current which it consumes. The data required to calculate this efficiency may be obtained when the electromotive force of the current, the resistance of the lamp when giving its light, and its illuminating power have been determined.

1. *Electromotive Force.*—The electromotive force, or fall of potential through the lamp, was measured by Law's method. A suitable condenser was charged by being put in communication with a standard Daniell cell, and then discharged through a high resistance galvanometer, the deflection of the needle being noted. This condenser was then connected to the two wires of the lamp, and again discharged through the galvanometer, the deflection being made the same as before by means of a variable shunt connected with the galvanometer. Since, with a given condenser, the charges it receives are proportional to the potentials of the charging currents, and since the discharge deflections of a galvanometer represent the quantity of these charges, it follows that the electromotive forces are proportional to these discharge deflections. If, however, as in the present case, the discharge deflections are made equal by means of shunts, then the electromotive forces are proportional to the multiplying power of the shunts.

2. *Resistance.*—The resistance of the lamp, when giving its light, was obtained by making the lamp one side of a Wheatstone's bridge, through which the main current was flowing. The second and fourth sides were formed of fixed resistances of known value, and the third side of an adjustable resistance. When the bridge is balanced the product of the two fixed resistances, divided by the adjusted resistance, gives the resistance of the lamp at the given candle-power.

3. *Illuminating Power.*—The illuminating power of the lamp was measured on a Bunsen photometer. At one end of the bar was the lamp itself, at the other end two standard candles, placed nearly in line. The plane of the carbon filament was placed at 45 deg. to the length of the bar, and each lamp was measured at 16 and 32 candles.

III.—Apparatus Employed.

1. *Condenser.*—The condenser used in these measurements had a capacity of 1 microfarad, divided into sections of 0·4, 0·3, 0·2, and 0·1. The dielectric was paraffined mica, and the brasswork was supported on ebonite pillars. Made by Latimer Clark, Muirhead, and Co., London, and exhibited in their section at the exhibition.

2. *Galvanometer.*—The galvanometer was a Thomson double-coil astatic instrument, enclosed in a square case with glass sides. Measured resistance, 6,550 ohms. Used with lamp-stand and scale in the ordinary way. Made by Elliott Brothers, London.

3. *Standard Cell.*—An ordinary Daniell cell, the copper plate being immersed in a saturated solution of pure copper sulphate, contained in the porous cell, and the zinc plate amalgamated in a saturated solution of pure zinc sulphate in the outer jar. One of a battery of ten cells forming a part of the Edison exhibit.

4. *Resistance Coils.*—*(a)* A set of standard coils, measuring from 1 ohm to 5,000 ohms. All other resistances employed were standardised by these. Made by L. Clark, Muirhead and Co., and a part of their exhibit. *(b)* A set of coils used in the Wheatstone's bridge. Compared carefully with set *(a)*. These coils formed a part of the exhibit of Edison.

5. *Wheatstone's Bridge.*—Four conducting wires of large size arranged on the table in the form of a rhomb. A test galvanometer was inserted between the obtuse angles of the rhomb, and a pair of shunt wires from the main conductors were attached at the acute angles. The first side of the rhomb contained the lamp to be measured, standing in its place on the photometer; the second side contained a fixed resistance of 5 ohms; the third side contained a variable resistance (Resistance *b*); and the fourth side a fixed resistance of 950 ohms. This bridge formed a part of the Edison exhibit.

6. *Photometer.*—The photometer employed was of the Bunsen form, having a double bar, 80 inches long, graduated in inches and in candles. The disc was of paraffined paper, with a plain spot in the centre. The disc box was movable on rollers, and contained inclined mirrors to facilitate the adjustment. The candles used were of spermaceti, made by Sugg, of London, to burn 120 grains (7·776 grms.) per hour. The entire apparatus was surrounded with heavy black cloth. Also a part of the Edison exhibit.

7. *Dynamo-Electric Machine.*—An Edison 60-light machine was used to furnish the current required. In this machine the field magnets, which are very long and heavy, stand vertically. The field is maintained by a shunt current, regulated by an adjustable resistance in its circuit. The bobbin is wound on a cylinder like that of Siemens, from which it differs, however, in its details. Its resistance was only 0·03 ohm, and the current delivered, at a speed of 900 revolutions, had an electromotive force of 110 volts. A part of the Edison exhibit.

IV.—Resistance of Lamps Cold.

The resistance of the lamps cold was measured on a Wheatstone's bridge of the ordinary form and in the usual way. The Edison lamps were taken at random from the stock on hand. The Swan lamps were furnished by Mr. Edmunds, the Lane-Fox lamps by Mr. Stewart, and the Maxim lamps by Mr. Lockwood. Twenty-four of each were taken (except the Lane-Fox, of which only fifteen were furnished), and ten selected from these for the tests. The measurements of the Edison and Swan lamps were

* By an Experimental Committee, consisting of Messrs. George F. Barker, William Crookes, F.R.S., and others.

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made by Mr. E. G. Acheson; those of the Lane-Fox and Maxim lamps by Mr. H. Crookes. The following are the results obtained:—

Number.	Edison.	Swan.	Lane-Fox.	Maxim.
1	237	74	53	73
2	233	50	56	84
3	268	54	56	76
4	260	73	56	74
5	251	55	54	74
6	228	72	50	71
7	227	39	53	68
8	249	67	52	63
9	219	55	57	65
10	237	52	63	73
Means	241	59	55	72

V.—Measurement of Efficiency.

1. *Experimental Results.*

A. *The Edison Lamp.*—In this measurement the entire condenser was employed. When charged with the standard cell and discharged through the galvanometer without shunt, a deflection of 310 scale divisions was obtained, as a mean of ten closely accordant experiments. The photometer readings were made by Mr. Crookes, the bridge readings by Major R. Y. Armstrong, and the galvanometer readings by Prof. G. F. Barker.

(*a*) *At* 16 *candles*—

Number of Lamp.	Photometer Reading.	Bridge Reading.	Galvanometer Reading.
1	16—14·75	35—34·5	75
2	16—15	35·0	74
3	16	30·5	74
4	16	32·3	73
5	16—17	33·4	73
6	16—17·5	36·0	73
7	16—15	36·6	78
8	16	34·5	75
9	16—19	37·5	74
10	16	37·7	74

(*b*) *At* 32 *candles*—

1	32	37·2	66
2	32	37·2	65
3	32	32·2	66
4	32	34·3	64
5	32	35·2	67
6	32	37·9	69
7	32	38·5	69
8	32	36·3	69
9	32	38·9	69
10	32	38·8	69

B. *The Swan Lamp.*—The entire condenser was used in these measurements also, the deflection being 310 divisions. The photometer was read by Mr. H. Crookes, the bridge by Mr. Crookes, and the galvanometer by Prof. Barker.

(*a*) *At* 16 *candles*—

Number.	Photometer.	Bridge.	Galvanometer.
1	16	119·5	136
2	16	161·7	145
3	16	148·8	137
4	16	113·5	122
5	16	145·9	134
6	16	122·1	138
7	16	229·0	179
8	16	135·1	145
9	16	159·5	146
10	16	171·0	145

(*b*) *At* 32 *candles*—

1	32	123·5	121
2	32	167·2	122
3	32	155·2	121
4	32	116·0	116
5	32	154·7	115
6	32	129·7	120
7	32	237·0	146
8	32	137·5	128
9	32	163·0	127
10	32	175·2	120

C. *The Lane-Fox Lamp.*—The entire condenser was employed, and the deflection was the same, 310 divisions. Mr. H. Crookes read the photometer, Mr. Crookes the bridge, and Prof. Barker the galvanometer.

(*a*) *At* 16 *candles*—

Number.	Photometer.	Bridge.	Galvanometer.
1	16	172·0	150
2	16	168·7	145
3	16	177·6	161
4	16	171·7	157
5	16	171·0	156
6	16	189·5	156
7	16	179·0	156
8	16	181·1	164
9	16	161·7	146
10	16	164·7	148

(*b*) *At* 32 *candles*—

1	32	178·7	135
2	32	175·5	129
3	32	181·2	149
4	32	175·2	148
5	32	175·7	143
6	32	192·3	143
7	32	186·2	146
8	32	184·5	146
9	32	167·3	133
10	32	172·0	129

D. *The Maxim Lamp.*—The entire condenser was used, as in the previous cases; but the deflection obtained was 315 divisions, owing probably to the higher temperature of the room. Photometer read by Mr. H. Crookes, bridge by Mr. Crookes, galvanometer by Prof. G. F. Barker.

(*a*) *At* 16 *candles*—

Number.	Photometer.	Bridge.	Galvanometer.
1	16	111·8	115
2	16	111·3	119
3	16	106·2	111
4	16	124·7	120
5	16	111·9	122
6	16	138·5	121
7	16	122·0	122
8	16	115·6	118
9	16	120·6	123
10	16	103·0	111

(*b*) *At* 32 *candles*—

1	32	114·6	102
2	32	114·8	106
3	32	109·7	100
4	32	128·6	112
5	32	114·5	113
6	32	140·8	113
7	32	126·9	110
8	32	120·4	105
9	32	126·5	110
10	32	109·7	101

E. *The Candle Record.*

Candle-power.	Loss in Grms.	Time in Mins.	Loss per Minute.
1. Edison Lamp.			
16	18·13	73	0·2483
32	21·22	84	0·2526
2. Swan Lamp.			
16 and 32	34·15	126	0·2695
3. Lane-Fox Lamp.			
16 and 32	40·70	153·75	0·2647
4. Maxim Lamp.			
16 and 32	26·90	104	0·2586

2. *Methods of Calculation.*

1. *Illuminating Power.*—The standard candle should burn 7·776 grms. spermaceti per hour, or 0·1296 grm. per minute. The two candles used should burn 0·2592 grm. per minute. The corrected candle power of the lamp, therefore, is obtained by the proportion: As 0·2592 is to the amount actually burned per minute, so is the observed candle power to the corrected candle power.

2. *Resistance* (*hot*).—From the theory of the Wheatstone bridge, the resistance of either side is equal to the product of the adjacent sides divided by the opposite side. In the bridge used for the measurement, the resistances in the two adjacent sides

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were 950 and 5 ohms. Hence by dividing their product, 4750, by the reading of the variable resistance observed, the resistance of the lamp hot is obtained.

3. *Electromotive Force.*—In Law's method the electromotive forces are proportional to the multiplying power of the shunts employed. Since with the Daniell cell no shunt was used, the multiplying power of the shunt used with the lamp-current represented directly the electromotive force through the lamp, in terms of the standard cell. The multiplying power of a shunt is the sum of the galvanometer resistance and the shunt resistance, divided by the shunt resistance. In this case the resistance of the galvanometer was 6550 ohms. Hence if S represent the resistance of the shunt, obtained by experiment, $\frac{6550 + S}{S}$ will represent the electromotive force. Since the electromotive force of a Daniell cell is not 1 volt, as here assumed, but 1·079 volts, strict accuracy would require the figures given to be increased in that ratio. Moreover, the small error arising from the inductive action of the needle on the galvanometer-coils has been regarded as unimportant.

4. *Current.*—By the law of Ohm the current strength is the quotient of electromotive force by resistance. Dividing the electromotive force in volts by the resistance in ohms the current strength is obtained in Ampères.

5. *Electrical Energy.*—The work done by a current is proportional to the product of the square of the current-strength into the resistance of the circuit. Or, since the electromotive force is equal to the product of the current-strength by the resistance, the energy is represented by the product of the electromotive force in volts by the current-strength in Ampères. This gives the energy in Volt-Amperes.

6. *Mechanical Energy.*—Since an absolute unit of work is done per second by an absolute unit of electromotive force in a circuit of one absolute unit of resistance, 1 Volt-Ampère represents 10^7 absolute units of mechanical work per second, or 0·10192 kilogrm.-metre. By multiplying the Volt-Amperes by 0·10192, the product is the mechanical work done in the lamp in kilogrm.-metres.

7. *Lamps per Horse-power of Current.*—One horse-power is 75 kilogrm.-metres per second. By dividing 75, therefore, by the number of kilogrm.-metres of work done in the lamp per second, the quotient is the number of such lamps maintained by a horse-power of current.

8. *Candles per Horse-power of Current.*—The number of candle-lights per horse-power of current is obtained, of course, by multiplying the number of lamps per horse-power of current by the corrected candle-power of each.

9. *Normal Lamps per Horse-power of Current.*—Conversely, by dividing the number of candles per horse-power of current by the normal value of the lamp in standard candles (in the present case 16 or 32), the number of normal lamps per horse-power of current is obtained.

3. *Calculated Results.*

A. *The Edison Lamp.*

(*a*) *At 16 candles*—

Number.	Candles (corrected).	Ohms.	Volts.	Amperes.
1	14·73	136·7	88·33	0·646
2	14·85	135·7	89·51	0·660
3	15·33	155·7	89·51	0·575
4	15·33	147·3	90·73	0·616
5	15·01	142·2	90·73	0·638
6	16·04	132·0	90·73	0·687
7	14·85	129·8	84·97	0·655
8	15·33	137·7	88·33	0·641
9	16·76	126·6	89·51	0·707
10	15·33	126·0	89·51	0·710

Number.	Volt-amperes.	Kilogram-metres.	Lamps per horse-power.	Candles per horse-power.
1	57·08	5·819	12·88	189·8
2	59·05	6·020	12·46	185·0
3	51·46	5·246	14·29	219·1
5	55·88	5·697	13·16	201·8
5	57·88	5·901	12·71	200·8
6	62·36	6·357	11·80	189·3
7	55·63	5·671	13·22	205·0
8	56·67	5·777	12·98	199·0
9	63·29	6·453	11·62	194·9
10	63·45	6·469	11·60	177·7

Edison Lamp (continued):—

(*b*) *At 32 candles*—

Number.	Candles (corrected).	Ohms.	Volts.	Amperes.
1	31·11	127·7	100·20	0·785
2	31·11	127·7	101·80	0·797
3	31·11	147·5	100·20	0·679
4	31·11	138·5	103·30	0·746
5	31·11	134·9	98·76	0·732
6	31·11	125·3	95·93	0·765
7	31·11	123·4	95·93	0·778
8	31·11	130·8	95·93	0·733
9	31·11	122·1	95·93	0·786
10	31·11	122·4	95·93	0·784

Number.	Volt-amperes.	Kilogram-metres.	Lamps per horse-power.	Candles per horse-power.
1	78·70	8·023	9·35	291·0
2	81·11	8·269	9·07	282·2
3	68·12	6·945	10·80	333·7
4	77·12	7·862	9·54	296·8
5	72·28	7·369	10·18	316·6
6	73·42	7·486	10·02	311·7
7	74·59	7·604	9·86	306·9
8	70·32	7·169	10·46	325·4
9	75·36	7·683	9·76	303·7
10	75·17	7·633	9·79	304·5

B. *The Swan Lamp.*

(*a*) *At 16 candles*—

Number.	Candles (corrected).	Ohms.	Volts.	Amperes.
1	16·61	39·75	49·16	1·237
2	16·61	29·38	46·17	1·536
3	16·61	31·92	48·81	1·529
4	16·61	41·85	54·69	1·307
5	16·61	32·56	49·88	1·532
6	16·61	38·90	48·47	1·246
7	16·61	20·74	37·59	1·812
8	16·61	35·16	46·17	1·313
9	16·61	29·78	45·86	1·540
10	16·61	27·78	46·17	1·662

Number.	Volt-amperes.	Kilogram-metres.	Lamps per horse-power.	Candles per horse-power.
1	60·80	6·199	12·10	200·9
2	72·57	7·399	10·14	168·3
3	74·63	7·609	9·86	163·7
4	71·47	7·286	10·29	170·9
5	76·42	7·791	9·63	159·8
6	60·38	6·155	12·18	202·3
7	68·13	6·946	10·80	179·3
8	60·64	6·182	12·13	201·5
9	70·62	7·201	10·41	173·0
10	76·75	7·824	9·59	159·5

(*b*) *At 32 candles*—

Number.	Candles.	Ohms.	Volts.	Amperes.
1	33·21	39·36	55·13	1·401
2	33·21	28·41	54·69	1·925
3	33·21	30·61	55·13	1·801
4	33·21	40·95	57·47	1·403
5	33·21	30·71	57·96	1·888
6	33·21	36·62	55·58	1·514
7	33·21	20·09	45·86	2·288
8	33·21	34·54	52·17	1·510
9	33·21	29·14	52·57	1·804
10	33·21	27·11	55·58	2·050

Number.	Volt-amperes.	Kilogram-metres.	Lamps per horse-power.	Candles per horse-power.
1	77·23	7·87	9·526	316·4
2	105·30	10·73	6·988	232·1
3	99·31	10·12	7·407	246·0
4	80·64	8·22	9·122	302·9
5	109·40	11·15	6·725	223·3
6	84·36	8·60	8·720	289·6
7	104·90	10·70	7·010	232·5
8	78·79	8·03	9·337	310·1
9	94·85	9·67	7·756	257·6
10	114·00	11·62	6·456	214·4

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C. *The Lane-Fox Lamp.*

(*a*) *At* 16 *candles*—

Number.	Candles (corrected).	Ohms.	Volts.	Amperes.
1	16·36	27·62	44·65	1·617
2	16·36	28·16	46·17	1·640
3	16·36	26·75	41·68	1·559
4	16·36	27·66	42·72	1·544
5	16·36	27·78	42·99	1·548
6	16·36	25·07	42·99	1·715
7	16·36	26·54	42·99	1·620
8	16·36	26·23	40·94	1·561
9	16·36	29·37	45·86	1·561
10	16·36	28·85	45·26	1·569

Number.	Volt-amperes.	Kilogram-metres.	Lamps per horse-power.	Candles per horse-power.
1	72·25	7·365	10·18	166·6
2	75·72	7·719	9·72	158·9
3	64·96	6·623	11·33	185·2
4	65·97	6·726	11·15	182·4
5	66·52	6·782	11·06	180·9
6	73·72	7·516	9·98	163·2
7	69·64	7·100	10·56	172·8
8	63·90	6·515	11·51	188·3
9	71·60	7·300	10·27	168·1
10	71·02	7·240	10·36	169·4

(*b*) *At* 32 *candles*—

Number.	Candles (corrected).	Ohms.	Volts.	Amperes.
1	32·71	26·58	49·52	1·863
2	32·71	27·07	51·78	1·913
3	32·71	26·09	44·96	1·723
4	32·71	27·11	45·26	1·669
5	32·71	27·04	46·80	1·731
6	32·71	24·70	46·80	1·895
7	32·71	25·51	49·16	1·927
8	32·71	25·75	45·86	1·781
9	32·71	28·39	50·25	1·770
10	32·71	27·62	51·78	1·875

Number.	Volt-amperes.	Kilogram-metres.	Lamps per horse-power.	Candles per horse-power.
1	92·25	9·405	7·98	260·9
2	99·04	10·100	7·43	243·0
3	77·47	7·898	9·50	310·7
4	75·56	7·702	9·74	318·6
5	81·03	8·261	9·08	297·1
6	88·69	9·042	8·30	271·4
7	94·74	9·659	7·77	254·0
8	81·70	8·330	9·00	294·6
9	88·93	9·066	8·27	270·7
10	97·07	9·896	7·58	247·9

D. *The Maxim Lamp.*

(*a*) *At* 16 *candles*—

Number.	Candles (corrected).	Ohms.	Volts.	Amperes.
1	15·96	42·49	57·96	1·364
2	15·96	42·68	56·04	1·313
3	15·96	44·73	60·01	1·342
4	15·96	38·09	55·58	1·459
5	15·96	42·45	54·69	1·288
6	15·96	35·10	55·13	1·571
7	15·96	38·94	54·69	1·405
8	15·96	41·09	56·51	1·375
9	15·96	39·39	54·25	1·377
10	15·96	46·12	60·01	1·301

Number.	Volt-amperes.	Kilogram-metres.	Lamps per horse-power.	Candles per horse-power.
1	79·06	8·060	9·305	148·5
2	73·59	7·503	9·996	159·6
3	80·51	8·208	9·137	145·9
4	81·11	8·269	9·070	144·8
5	70·46	7·183	10·440	166·7
6	86·61	8·830	8·494	135·6
7	78·62	7·832	9·577	152·9
8	77·71	7·923	9·466	151·1
9	74·73	7·619	9·844	157·2
10	78·09	7·961	9·421	150·4

Maxim Lamp (continued):—

(*b*) *At* 32 *candles*—

Number.	Candles.	Ohms.	Volts.	Amperes.
1	31·93	41·45	65·22	1·573
2	31·93	41·34	62·79	1·519
3	31·93	43·30	66·50	1·536
4	31·93	36·94	59·48	1·610
5	31·93	41·49	59·48	1·434
6	31·93	33·74	58·96	1·748
7	31·93	37·43	60·54	1·617
8	31·93	39·45	63·38	1·607
9	31·93	37·55	60·54	1·612
10	31·93	43·30	65·85	1·521

Number.	Volt-amperes.	Kilogram-metres.	Lamps per horse-power.	Candles per horse-power.
1	105·00	10·710	7·006	223·7
2	95·38	9·724	7·713	246·3
3	102·10	10·410	7·203	230·0
4	95·79	9·766	7·680	245·2
5	85·29	8·695	8·625	275·4
6	103·00	10·510	7·138	227·9
7	97·93	9·984	7·512	239·8
8	101·80	10·380	7·225	230·7
9	97·62	9·954	7·536	240·6
10	100·20	10·210	7·346	234·5

4. *Summary of Results.*

(*a*) *At* 16 *candles*—

	Edison.	Swan.	Lane-Fox.	Maxim.
Candles	15·38	16·61	16·36	15·96
Ohms	137·4	32·78	27·40	41·11
Volts	89·11	47·30	43·63	56·49
Amperes	0·651	1·471	1·593	1·380
Volt-Amperes	57·98	69·24	69·53	78·05
Kilogram-metres	5·911	7·059	7·089	7·939
Lamps per horse-power	12·73	10·71	10·61	9·48
Candles per horse-power	196·4	177·92	173·58	151·27
Lamps of 16 candles per horse-power	12·28	11·12	10·85	9·45

(*b*) *At* 32 *candles*—

	Edison.	Swan.	Lane-Fox.	Maxim.
Candles	31·11	33·21	32·71	31·93
Ohms	130·03	31·75	26·59	39·60
Volts	98·39	54·21	48·22	62·27
Amperes	0·7585	1·758	1·815	1·578
Volt-Amperes	74·62	94·88	87·65	98·41
Kilogram-metres	7·604	9·67	8·936	10·03
Lamps per horse-power	9·88	7·90	8·47	7·50
Candles per horse-power	307·25	262·49	276·89	239·41
Lamps of 32 candles per horse-power	9·60	8·20	8·65	7·48

VI.—Conclusions.

The following conclusions seem to be sustained by the results which have now been given:—

1st.—The maximum efficiency of incandescent lamps in the present state of the subject, and within the experimental limits of this investigation, cannot be assumed to exceed 300 candle-lights per horse-power of current.

2nd.—The economy of all lamps of this kind is greater at high than at low incandescence.

3rd.—The economy of light-production is greater in high resistance lamps than in those of low resistance, thus agreeing with the economy of distribution.

4th.—The relative efficiency of the four lamps examined, expressed in Carcel burners of 7·4 spermaceti candles each, produced by one horse-power of current, is as follows:—(A.) At 16 candles: Edison, 26·5; Swan, 24; Lane-Fox, 23·5; and Maxim, 20·4. (B.) At 32 candles: Edison, 41·5; Lane-Fox, 37·4; Swan, 35·5; and Maxim, 32·4. To double the light given by these lamps the current-energy was increased, for the Maxim and Lane-Fox lamps, 26 per cent; for the Edison lamp, 28 per cent: and for the Swan lamp, 37 per cent.

Telegraphic Conference.—A conference of delegates of several of the West India Colonies has met at Barbadoes, and proposed a scheme for improving telegraphic communication between the West Indies and Great Britain.

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THE ELECTRICIAN.

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THE ELECTRIC LIGHT AS A LUXURY.

For want of substantial argument the journals devoted to gas lighting interests have latterly taken to disparaging their detested rival by what, in the social relations of life, would be called flatulent sermonising. The electric lighting companies are immoral and unscrupulous speculators; the evidence relating to the new light is fraudulently misstated or suppressed; the light itself is an impostor, and the people who favour it are wantonly guilty of an attack upon property. Moreover, we are informed that the electric light is not needed; it is a superfluity, a wasteful expenditure of light, an infraction of the laws of nature, "tending to turn night into day"—is, in short, a luxury of the sinful sort which pious vestries and wealthy citizens alike should religiously eschew.

As a rule, we are not enamoured of the *tu quoque* mode of reasoning; but here is an occasion when, if ever, the "you're another" method is the best and, perhaps, the only argument possible. Gas is itself a luxury. Not so many years ago it was an unobtainable luxury. Compared with oil-lamps in the streets, it was and is a blessed luxury; in some situations it is still a luxury for the distant future only; while in many others which "never are, but always to be, blessed" we are content to think that the luxury of gas can never pollute them. Pope must have had the gas champions in his prophetic mind when he made "Whatever is, is right" to rhyme with "Nature's light." Evidently, in their estimation, gas is the light referred to; and, as gas *is*, gas is right. We do not dispute the proposition; we only want to remind our critics, as the self same poet reminds his own, that

> . . . This world, 'tis true,
> Was made for Cæsar—but for Titus too.

If the electric light is a luxury it is a clean and wholesome luxury, which is, to put it mildly, more than can always be said for gas; and even should the world not tire of gas, as it did of Cæsar, there is plenty of room for the electric light, as there was for Titus, "whose virtue" (another proof of what Pope must have been dreaming of) "sighed to lose a day!"

Seriously, however, we are prepared to accept this challenge as to the electric light being a luxury. This is an age of luxury, and an age quite able to pay for what it likes. We cannot pronounce with confidence upon the economics of asphalted roadways or of high-heeled shoes, but the public pay for them and presumably like them; the cost is a minor matter, the luxuries, such as they are, outweighing all other considerations. It is certain that ladies do not consult the interests of virtuous cordwainers who stick to low heels, nor have the horses been questioned as to their private opinion about asphalte. In all human probability the public will be equally oblivious as to the moralities and the conveniences of gas manufacturers. If the electric light is preferred it will be demanded, and none the less so for its costing a trifle more than gas.

We put the case in this wise not as admitting that the cost of gas is, or at all events, need be, less than that of electricity, but merely to show that we by no means rely upon the superior economy of the new mode of lighting. We have repeatedly deprecated the reticence which has hitherto prevailed in respect to the cost of electric lighting. It has come to be acknowledged that what is charged for it is no criterion of what it actually costs. The reason is intelligible, but it is damaging, and is altogether a mistaken policy. The public, if frankly taken into confidence, would be quite able to understand and make allowances for the unavoidable expenditures on experimental installations confined to limited areas; and we feel sure that the result would have been preferable to the state of things described by the President of the Royal Society in his evidence before the parliamentary committee. "Nobody," said Mr. Spottiswoode, "knows accurately [what the cost of producing electricity is], and those who might know, certainly will not divulge at present." The real reason is because "those who know" know also that different methods differ in cost, and nobody is yet quite sure whose method is the cheapest. But the general public, and especially the gas shareholding public, are apt to construe silence as proof of a bad case, whereas it is only evidence of caution among various competitors. In this stage of the competition there would probably be the same amount of uncertainty as to actual cost even were the highest estimate known to be much lower than what is charged for gas.

In some quarters, however, there are signs that this barrier of silence is being broken down. One or two of the parliamentary witnesses—notably the one representing Mr. Edison—went into explicit figures which showed that he at all events had no apprehensions on the score of expense. If these calculations are borne out by practical experience—and there is reasonable ground for believing that they will be—the prospects of electric lighting even as an economical competitor with gas are well assured. Several letters from responsible persons who have lately installed the light on their own account, and communicated the results to the newspapers, tell the same story. The high authority whose words we quoted above gave it as his opinion that the cost was fairly comparable with that of gas even when, as in his own case, the electric light is introduced into a single establishment and on a small scale. To Mr. Spottiswoode, however, its relative cost was not a matter of first moment; he liked the light, it saved his pictures and books from disfigurement, and did not befoul the atmosphere. He

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thought he paid no more for it than for gas, but if he did he would willingly incur the trifling extra expense for the—luxury. This we may safely conjecture will be the general verdict in the long run, and all the sermonising in the world will not, in that case, prevent the latest boon of science becoming not merely a luxury but a necessary of civilised life.

CORRESPONDENCE.

WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Harbord's letter to you is a most amusing one. From beginning to end it is a tissue of denials, without a single word of proof to support these denials. It does not require a wise man to write such a letter. When fixing a man of Mr. Harbord's proclivities—for unsupported assertion—it does not do to give him much rope; I shall, therefore, notice only a part of his letter. He writes, "The bending of the two gas flames in one direction does not disprove induction; it only shows the passage of a current, and is no evidence of electrical matter passing through the glass of the jar." This passage is important in two respects. First, he admits that the bending of a gas flame does indicate the direction in which a current of electricity moves. Second, as the two flames are bent both in the same direction, therefore the currents of electricity they indicate must both move in the same direction. As Mr. Harbord is an out and out supporter of the theory of two electricities, before proceeding further it is necessary for me to keep my foundation clear by noticing the fact that I have in your pages had discussions with Mr. J. E. H. Gordon and Prof. Silvanus P. Thompson about the electricity which comes from a frictional machine. These gentlemen maintained in their published writings that one kind of electricity is given out at the prime conductor of a frictional machine, and that another kind of electricity is given out at the cushion of the machine. This I denied, and produced experimental proof showing that only one electricity passes through a frictional electrical machine, namely, that electricity goes from the ground up the chain of the cushion, and then from the cushion to the glass, and from that to the prime conductor, where it is delivered off. Mr. Gordon and Professor Thompson were unable to rebut the proofs I gave in support of the foregoing fact, but when Dr. Shettle took to writing in your pages, under the title "What is Electricity?" in his first letter, Vol. VIII., page 199, he wrote:—"By way of recapitulation, I believe I may say that I have thus shown . . . . that in static electricity the force developed by friction must be equal in the two forms of matter subjected to the process, and that force originated by motion in two directions must itself partake of the two directions." This is a direct contradiction in words by Dr. Shettle of the experimental proof which I gave in your columns concerning the action of the frictional machine. The foregoing passage of Dr. Shettle's is an assertion that one kind of force or electricity is delivered at the prime conductor of a frictional machine, and that another kind of force or electricity is delivered at the cushion of the machine. This contradiction by Dr. Shettle is an unsupported assumption that my experimental proof is wrong, by which I have shown that there is only one electricity passing through the frictional machine. This unsupported assumption he gives as a foundation of his theory of electricity without giving one atom of proof that two currents of force or electricity issue from a frictional machine. From the foregoing reason Dr. Shettle's theory of electricity is worthless, because he has founded it on an assumption which is false. Having thus made plain the foundation for my argument with Mr. Harbord, I now proceed. (See page 62, Fig. 6.) The electricity which comes from the ball A on the prime conductor of the frictional machine bends the flame B towards the right hand, and it also causes the flame F to move toward the right hand; and these flames teach us that the currents of electricity which move them do also move in the same direction; and as the flame B is bent to the right hand by the electricity coming from the ball A and passing into the Leyden jar D it is manifest that the bending of the flame F to the right hand indicates that a current of electricity is moving from the outside of the Leyden jar D, through the wire E, and passing on to the ball H. Now, the question to be solved is, Where does this current of electricity come from which passes from E to H? When the Leyden jar D is charged in the usual way, the motion of the flame F continues in the same direction as the flame B until the jar D has received its full charge, then immediately on this taking place the motion of the flame F stops, and the flame stands upright. Will Mr. Harbord explain the cause of this, when he has taken along with it the following fact. When the Leyden jar is being charged while the paraffin plug and wire are placed in its mouth (see Fig. 7, page 63), the flames B and F both move to the right hand, but during this arrangement of the apparatus there is no period ever reached when the flame F will cease to bend toward the right hand; it will continue to move in this direction as long as electricity is passed into the interior of the jar D. If the electricity which thus continuously moves the flame F to the right hand does not come from the interior of the jar and through the glass will Mr. Harbord give in your columns experimental proof as to where the said electricity does come from? I may add that it is a well-known fact that there are some kinds of glass of which if bottles are made it is impossible to convert these bottles into Leyden jars, because the glass allows all the electricity to pass through it. In Mr. J. E. H. Gordon's "Physical Treatise on Electricity and Magnetism," Vol. II., pages 120—123, he gives the particulars of experiments made in 1877 with four kinds of glass which had been made a few weeks before. He tested the capacity of these four kinds of glass with reference to electricity, and eighteen months after he again tested with electricity these same samples of glass, and found that the eighteen months had made a difference of 25 per cent. in the capacity of these samples of glass for electricity. Seeing from all these facts that electricity can go through some kinds of glass with perfect freedom, while it goes with difficulty through other kinds of glass, and that age affects the capacity of glass in this respect, I maintain that the only rational conclusion which can be come to on this subject is that the atoms of electricity must be of a definite size, whereas the pores in glass are not of a definite size. In new glass the pores are large, and in old glass they are small. The contraction of the pores of glass may arise from two causes—*first*, the shrinkage of the glass by age; *second*, the filling up of the pores of the glass by extraneous matter. That extraneous matter does affect the pores of glass is manifest by the discovery of Professor Jenkins, that when glass has lost its power of insulating electricity the power of insulation may be restored to it by "the glass being immersed for twenty-four hours in distilled water, and be allowed to dry for the same length of time without rubbing it with anything whatever." This discovery has been successfully used by Professor Carlo Marangoni for the restoration of the glass plates of Holtz machines which had lost their power of insulation through long use. If the difference of the size of the pores of glass is the reason why some kinds of glass insulate electricity, while other kinds of glass allow electricity to pass freely through them, then the size of the atoms of electricity are in reality the means by which we test the size of the pores of a piece of glass, and hence electricity must be matter and not force, because matter is divisable into atoms, but force cannot be divided into atoms.

I now turn to Dr. Shettle. In his first letter to you, under the title "What is Electricity?" he attempted to strike a blow at some of the contents of my previous letters published in your columns. By his doing so he threw down the gauntlet to me. I took it up and answered him. Is it to be a matter of history, recorded in the pages of *The Electrician*, that Dr. Shettle challenged an opponent and then shrank

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from the contest when he found he could not answer without compromising his own statements about facts ?—Yours, &c.,
JAMES JOHNSTONE.

Experiment Rooms, 1, James-square,
Edinburgh, June 12, 1882.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent has taken a vast amount of trouble to prove that a current of electricity moves in a given direction, and concludes his letter by stating, "If its contents do not convince Dr. Shettle that he is wrong in maintaining that electricity is energy and not matter, I may in another letter enter into details in criticising Dr. Shettle's theory of electricity, in the explanation of which he has used a great flow of scientific words, which result in the confounding of some scientific facts." After declining to enter upon a consideration of Mr. Johnstone's scientific facts, as I have done, I should not have deemed it necessary to write more now were it not to relieve Mr. Johnstone from some errors into which he appears to have fallen. 1st. I have never stated that electricity is energy and not matter, or matter and not energy; but that, secondly, electricity is a *peculiar* condition of matter, the energy of which, when in motion—other things being equal—is in proportion to the strength of the current. Mr. Johnstone stated that electricity is a *peculiar kind of matter*. In this view I cannot concur, but I have no objection to any amount of criticism or to Mr. Johnstone's maintaining his opinion if he thinks proper to do so.—Yours, &c.,
R. S. SHETTLE.

SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Now that much attention is being given to the subject of storage of energy it may be as well to point out that the problem to be solved is more of a chemical than an electrical nature, for as a matter of fact in all so-called accumulators of electric force it is always chemical work that is done, and which by being undone, so to say, gives out force corresponding to that expended in the original primary charging of the secondary batteries.

From the laborious investigations of M. Planté and others it is pretty certain that lead is the most suitable metal for employment in the construction of accumulators, and since peroxide of lead is the other active substance formed by charging the accumulators, it becomes a question of what form of leads can be most profitably employed, and how the red lead or peroxide of lead can be best placed as against the metallic lead. Before the use of secondary batteries can become at all wide-spread it is essential that great improvements must be made upon the forms at present before the public, and in calling attention to a new accumulator which is said to have excited considerable interest already, we can only make general remarks, because, so far, the details are not made known, although the time is fast drawing near when the final specification of the patentees must be deposited.

It is said, then, that in the new Donnithorne battery, as it is termed, the lead which is employed is in the very best form, chemically speaking; that is to say, it presents the greatest possible surface while presenting corresponding lightness in character. Then, again, no felt or other destructible material is used in the battery, but an altogether new and simple plan is adopted of supporting the red lead or other lead compound to be employed. The battery is also provided with a simple mechanical contrivance, whereby loss of energy is said to be avoided when the accumulator is not in active use. As compared with the batteries bearing the names of M. Faure and Messrs. Sellon and Volckmar, it is said that the Donnithorne battery is very much lighter, is more portable, less costly, and considerably more receptive in character. There are at least three important plans of constructing the battery in question, and if the opinion of Mr. C. T. Kingzett—the chemist who has been professionally consulted by the patentees throughout—should be confirmed by that of other authorities, the new departure promises well for the development of electric lighting for domestic and other purposes.—Yours, &c.,
X.

CURATIVE ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Desmond FitzGerald says:—"When, however, the animal body is made to form part of a magnetic circuit, not only is it impossible to demonstrate the production of any physiological effect, even with the most powerful magnets, but, if we choose to assume that such effects occur, their production must be that of the vascular or circulatory system, or, in other words, that the arterial and venous flow must be more or less impeded." In my reply to Mr. Donovan I have pointed out that the laws governing magneto-electricity are bound to hold good, whether in a living body or out of it, and to this I adhere; but, to make the fact still more patent to Mr. Desmond FitzGerald, I would point out that the power generated under magneto-electricity depends upon the power of the moving magnets. In the case in question it is impossible to deny that the polarity of the blood corpuscles is increased by the artificial magnets. But there are, notwithstanding, several reasons why this increased polarity of the blood corpuscles should not slow the circulation as suggested, amongst which I would name—1st. the shape of the corpuscles, which are bi-concave; 2nd. the low polarity, which is manifested principally on the surface of the discs, as shown by the manner in which they cohere by their flat sides when at rest and undergoing the process of coagulation; 3rd. the rapid motion to which they are subjected from the action of the heart, for it has been shown that the blood makes the circulation of the system in about one minute; 4th. under such circumstances, by the laws of magneto-electricity, the circulation ought to be rendered more rapid, for the nerve current must be in proportion to the polarity of the blood corpuscles, and the action of the heart to the strength of the nerve current.

I do not dispute the influence of flannel in stimulating the skin by friction, and so favouring vital action, but I do mean to assert that these magnetic appliances produce a like friction in the interior of the body, and in proportion to the increased amount of friction they are productive of comparatively greater results.—Yours, &c., R. S. SHETTLE.

Reading, June 3, 1882.

NOTES ON THE CRYSTAL PALACE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The editorial note appended to my letter in your last issue with reference to the necessity for taking into consideration the class of carbons used hardly accords with the result of my conclusions, as you will see on closer examination.

In the first place, writing from memory, I believe I was informed that those used in the Pilsen lamp were made by Messrs. Johnson and Phillips, as were also those used by the British Electric Light Company in their Brockie lamp. Again, do not Messrs. Siemens manufacture their own?

On the other hand, Mr. Crompton is said to burn Carré carbons exclusively, and in his treatise says that those made by the Brush Company are superior in most respects to any others.

It is, therefore, apparent that my observations do not tend to show that the best French carbons give the best light; but, under any circumstances, it is no unfairness to suppose that each competitor was doing his utmost to outpace his rivals in the race for popular favour, and I consider that I was perfectly justified in assuming that each system was shown to the best advantage.

In reply to your correspondent, "X.Y.Z.," I cannot do better than refer him to your contemporary, the *Telegraphic Journal*, of June 10, where he will find the Self-Generating Company treated to an exhaustive criticism; and I may add that I also wrote to the secretary, a Mr. Farie, for an explanation of the extraordinary statements which appeared in

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their prospectus, but the only fact elicited was that the "self-generator" was a galvanic battery "specially designed for durability," further information being refused on the ground that the specification had not been filed.—Yours, &c.,

G. A. Moore.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: On reading your correspondent's notes on the different systems at the Electrical Exhibition, I could not help thinking how different things would look if further details were given respecting the exhibits he criticised.

As I am living near the Palace, and visited it nearly every evening during the exhibition, perhaps you will afford me space to add a little more, from an outsider's point of view. I must add that I not only *saw* the things at work, but made it my business to become tolerably acquainted with the working of most of them.

The Pilsen, I believe, was the steadiest lamp burning; but was it as economical as others—that is, did it give out in light the same amount per horse-power as other systems? I rather doubt it.

Again, your correspondent takes Siemens, and, considering only its steadiness, is greatly misled—that is, from a buyer's point of view. As an instance of this, take the far greater cost of this system compared with another in lighting up the City.

We are told Jablochkoff can still compete with a great many. In changes of colour, I presume he means; for if he saw the lights in the gallery and other parts of the building he would think, with others, they would be eminently suited for outdoor use on a firework night. Now, as to the disappointment in the Crompton lamp I must say a little. I, too, was somewhat disappointed after seeing the lamps burn so well at the earlier part of the exhibition; and having the curiosity to inquire as to the cause found out only too good a reason, for the machines were running at nearly 200 revolutions per minute too little. The large engine which was driving this and five other companies' machines was overloaded, and, consequently, did not keep up its speed.

The Joel is a very pleasant light to look at, but is supposed to be rather dear, when you can get 500 candle-power from an arc light with half horse-power, and from the semi-incandescent you get something like 200.

As to the Bürgin machine, I have seen it working many a time, and invariably admired its compactness and look of durability; but why it should be supposed to absorb more power in proportion to its work than other machines I fail to see.

I may here add, in closing these remarks, that I have been informed that Messrs. Siemens prefer the upright form of their machine on account of certain induction which is experienced when the machine is lying flat on the ground.—Yours, &c.,

A Closer Observer.

Gipsy Hill, June 14, 1882.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read with interest the letter from Mr. G. A. Moore in your issue of the 10th inst. I concur in several of his opinions, particularly those expressed in the first and seventh of his notes, where he states the Pilsen lamp to be the steadiest and the Brush light to be trying to the sight. It is rather, however, with regard to the seventh note that I should like to make a few remarks. Mr. Moore there states that "the price of all dynamo machines of the present day is altogether too utter to tempt the majority of persons to whom the light would be otherwise an advantage." This opinion one can hardly fail to agree with, and I think it might well have been extended to the arc lamps. I have myself heard it stated by several large mill owners and manufacturers in the north of England that they should adopt the light in their works but for the cost of the dynamos and lamps. It is, I think, in this question of cost that now lies the solving of the problem whether electricity will supersede gas. It has been amply demonstrated that the electric light is a good and serviceable light. Can it be produced at a sufficiently reasonable cost to admit of its general adoption?

Now, a great many different systems have recently been brought out by companies floated for the purpose, so many, in fact, as to bewilder intending investors and employers of the light. I have interested myself in reading the prospectuses of all those companies, in the hope of ascertaining which is the best and cheapest, and it has struck me as being very significant that in most cases they make hardly any mention of the all-important question of cost. A reference to the current value of the Anglo-American Brush Company's shares, and to the Government report upon that company's lighting of the South Kensington Museum, appears to be considered by many new companies a sufficient recommendation of their own system. Others content themselves with a vague and general statement that their light is remarkable for its efficiency, cheapness, &c. Now, these credentials are, in my opinion, wholly insufficient and undeserving of the public confidence and support.

There is one exception to the above criticism, and that is in the case of the Laing Electric Light and Power Company. This company's prospectus publishes *in extenso* (not mere extracts from) Professors Ayrton and Perry's reports upon their system, and, what is more important, gives the actual manufacturing cost of their machines and lamps.

A dynamo, together with twenty-one arc lamps each, to be of an intensity of 500 actual (upwards of 1,500 nominal) candle-power is stated to cost £163 16s. 2d. to manufacture, 50 per cent. for profit added to which makes a total of £245 14s. 3d. I see by the Hammond Company's (Brush system) printed price list that their charge for a dynamo and sixteen lamps of 2,000 nominal (or about 500 actual) candle-power is £656. The balance is, therefore, enormously in favour of the Laing Company, and if their light, which is I believe as yet comparatively unknown in this country, proves to be up to the mark the inventor may fairly claim to have made a great stride of improvement in electric lighting. I have made the above comparison with the Brush system, because it has hitherto been the most successful, and also because it is difficult to ascertain what many of the other systems actually do cost. I suspect, however, they would be more explicit on the point were they able to show such favourable figures as those given by the Laing Company. I would add that I do not consider such lighting as that hitherto carried on in the City of London or the South Kensington Museum to be necessarily a fair criterion of the cost of lighting. I should like to know how much profit has been made upon those contracts.—Yours, &c., X. Y. Z.

M. PHILIPPART AND MR. VOLCKMAR.

We have received from Mr. Volckmar the following copy of a letter which has been addressed to him by M. Philippart:—

[Copy.]

"446, Strand, W.C.,
"June 7th, 1882.

"Dear Sir: I acknowledge before we enter into our conventions that you have given me full explanations upon the circumstances which have been on my part the object of personal attacks affecting your honour; I, therefore, retract every expression and every accusation which, publicly or otherwise, have been used by myself or on my behalf, which could reflect in any way upon your honour.

"From to-day we, on both sides, loyally put an end to any dispute or lawsuit between us.—Yours faithfully,

(Signed) "S. Philippart.

"Monsieur E. Volckmar,
"74, Hatton-garden."

Blasting by Electricity.—Electricity is now employed in firing the charges in blasting stone in the quarries at Huntington, Indiana, U.S.A., and it is estimated that a saving of 50 per cent. is effected over the old plan.

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THE CRYSTAL PALACE EXHIBITION.

The Post Office Telegraph Exhibit.

Electric telegraphy is undoubtedly the most useful application of electric science. Though the name is familiar to all classes of people, both young and old, only a few know more than that the wires they have seen are the mediums of secret communications. We have heard many exclamations of surprise from visitors at the Crystal Palace during the working of telegraphic instruments, hence we are of opinion that such an exhibit as that so admirably furnished by the Government must have done a large amount of good. Anything which aids the education of a people must surely benefit the whole nation. Prior to the beginning of this century several attempts were made to transmit letters and words afar off by means of frictional electricity, but all such experiments failed. The

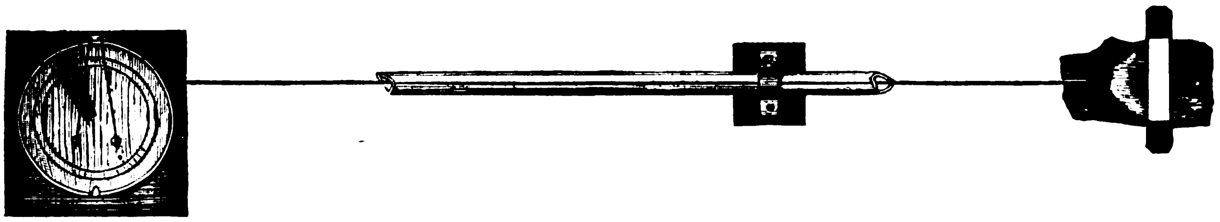

Fig. 1.—Ronald's Telegraph. Showing Specimen Exhibited.

discovery of *galvanic* or *voltaic* electricity was destined to produce a marked change, without which practical electric telegraphy would be impossible. It is curious to find that new discoveries rarely meet with ready acceptance. In "Bryan's Lectures on Natural Philosophy," published in 1806, the author, after debating upon frictional electricity, refers to galvanic effects, and says:—" Some persons suppose

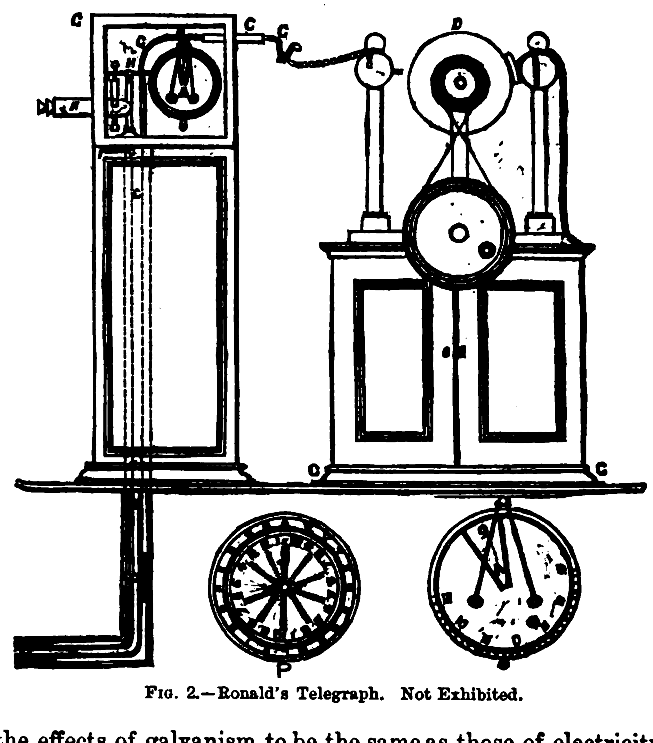

Fig. 2.—Ronald's Telegraph. Not Exhibited.

the effects of galvanism to be the same as those of electricity, though their mode of operation differs considerably. . . . . . Many cruel experiments have been tried in this science, at which human nature shudders. . . . . It is a science I am not desirous of cultivating." Now, the electrical power called *frictional electricity,* though small in quantity, is of high intensity. In fact its condition, in comparison with that developed by the galvanic battery, may be represented by very high pressure steam compared with low pressure steam, or perhaps, better still, water under a high head of pressure compared with water under a low head. It is evidently much more easy to make joints and pipes capable of conveying the low pressure water than that at high pressure; and just so with the two states of electricity, the degree of insulation of the conducting wires which will perfectly suffice for the low intensity, or voltaic currents, would provide no insulation at all for the high intensity or frictional charges. The invention, therefore, of the galvanic battery constituted a most important era in electrical applications.

The Post Office apparatus, past and present, occupied two long counters, and was arranged in chronological order by Mr. J. W. Willmot. This arrangement enabled visitors to trace with ease the development of practical telegraphy from the year 1816. Unfortunately the descriptions in the catalogue did not follow the same order; but each section of apparatus was clearly indicated by bold lettering on the tables. The whole was in charge of Messrs. Probert and A. Graves, of the Postal Telegraph Department.

At one end of the exhibit might be noticed an abstract from the *Chemist*, 8th January, 1825, on the "Motion of the Electric Fluid," in which the writer, after commenting on Mr. Barlow's investigation as to the diminution of electromagnetic effects by increased resistance, concludes with this phrase, "*Hence, the idea of making electric telegraphs is quite chimerical.*" Following on this was a small case, kindly lent by Mr. Latimer Clark, containing "the earliest existing specimen of an electric telegraph" (so the printed notice stated)—that of Ronalds, 1816 (Figs. 1 & 2). We understand that Ronalds used the divergence and collapse of pith balls as signals to direct the attention of an observer to the letter, which, at the moment of such divergence or collapse, was in view through a small opening in a clock dial. At the two

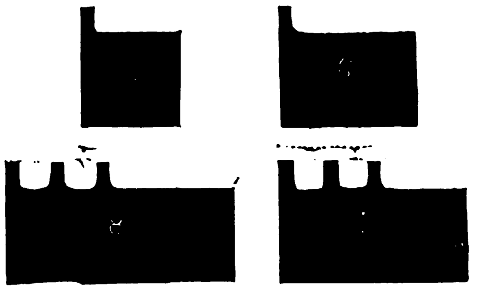

Fig. 3.—Morse's Type for the Electro-Magnetic Telegraph.

ends of the line of communication were placed clocks, going with absolute isochronism, and carrying light discs bearing letters around their circumference. Thus the clocks being started with like signals, visible through an opening in a screen or dial placed before the discs, would, so long as they went perfectly together, continue to show in succession signal after signal simultaneously. The attendant at one station would, therefore, know that when any letter was visible on his clock, the same letter (if the clocks went right) would be visible on the other, and he could, therefore, by waiting for the appearance of the letter required on his dial, call the attention of his correspondent to this letter by suddenly charging or discharging the wire, and thus producing the divergence or collapse of the pith balls. Ronalds, however, employed frictional electricity of high intensity, and for the reason already stated this system could not have become practicable. Fig. 1 gives details of the system, showing the line wire, pith balls, &c., and is a facsimile of the specimen

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exhibited. Fig. 2 shows the instrument, together with the mode of obtaining the current, &c. We described this apparatus in Vol. VIII., p. 341, in detail. P is a brass plate divided into 20 equal parts, fitted on the seconds arbor of a clock. Each division is marked by a figure, a letter, and a preparatory sign. The figures are divided into two series, 1 to 10, and the letters are arranged alphabetically, leaving out I, Q, U, W, X, and Z. Before or over this disc is fixed another brass plate capable of being moved by the hand round its centre, which had an aperature of such dimensions that whilst P was carried round by the motion of the clock, only one of the letters, &c., can be seen at the same time. In front of this pair of plates is suspended an electrometer of Canton's pith balls. D is the frictional machine for generating the current, CC conductors, G instrument case, E the insulated conductors. The apparatus shown in Fig. 2 was not exhibited at the Crystal Palace. Mr. Latimer Clark's case also contains Professor Morse's autograph, his small glazed porcelain in-

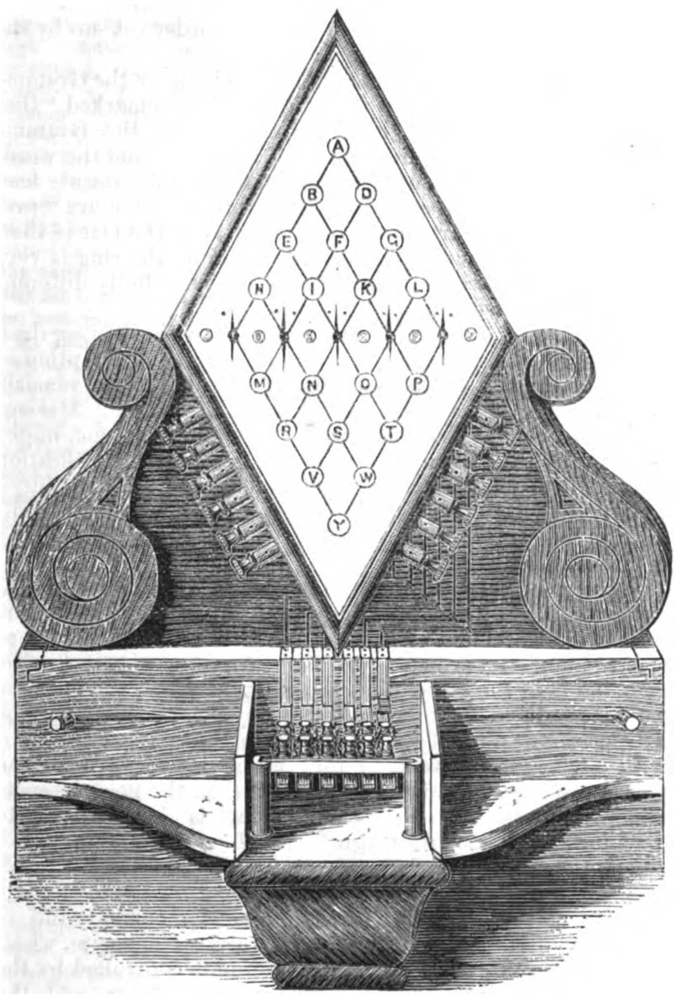

FIG. 4.—Original Five-Needle Instrument of Wheatstone.

sulators, and his "original type cast in December, 1832, for the Electro Magnetic Telegraph" (Fig. 3). Morse was the first to introduce a recording telegraph system. His first thoughts, however, were that accurate transmission could only be effected by automatic means, hence, type of the sort shown above were set up in a composing stick, and urged forward by an endless band, so that the projections of the type successively lifted one end of a lever, causing intermittent currents to actuate a suspended lever, carrying a pencil over a propelled band of paper. Zig-zag lines appeared on the ribbon, the points and spaces of which represented numbers, and the numbers indicated words. A telegraphic dictionary was necessary for this system. This rude invention was publicly exhibited for the first time on September 2nd, 1837, and worked successfully through one third of a mile of wire.

Wheatstone's five needle instrument of 1837 (Fig. 4) stands in striking contrast with his later automatic system on the opposite counter. The former required *five* wires for its operation, and was slow in its action, whereas the latter needs one wire only, and can signal at varying rates from 10 to 200 words per minute. The five-needle instrument was the earliest form used for publicly demonstrating the practicability of an electric telegraph. Two such instruments were in communication between Euston and Camden Town on the London and Birmingham Railway in 1837.

Mr. Latimer Clark in his inaugural address before the Society of Telegraph Engineers, gave the following account of the first trial of this system :—

"Late in the evening of June 25, 1837, in a dingy room near the booking office at Euston-square, by the light of a flaring dip candle, which dimly illuminated the surrounding darkness, sat the inventor Wheatstone, with a beating pulse and a heart full of hope. In another small room at the Camden Town Station, where the wires terminated, sat Mr. W. Fothergill Cooke, his co-patentee, and, among others, two witnesses well known to fame, Mr. Charles Fox and Mr. Stephenson. These gentlemen listened to the first word spelt by that trembling tongue of steel, which will only

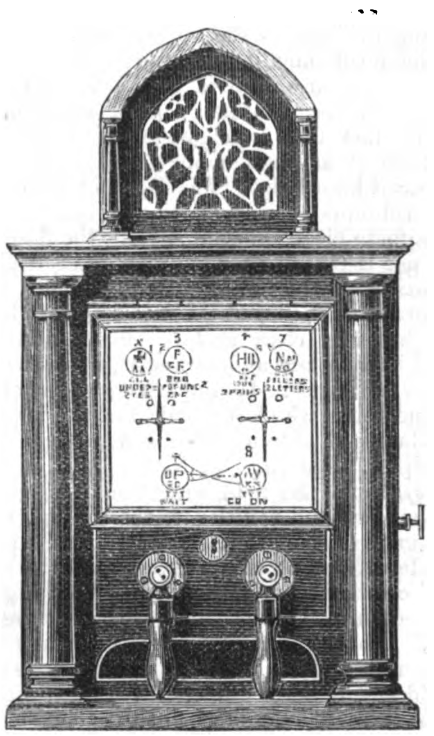
FIG. 5.—Original Two-Needle Instrument.

cease to discourse with the extinction of man himself. Mr. Cooke, in his turn, touched the keys and returned the answer. 'Never did I feel such a tumultuous sensation before,' said the professor, 'as when, all alone in the still room, I heard the needles click ; and, as I spelt the words, felt all the magnitude of the invention, now proved to be practical, beyond cavil or dispute.' Mr. Fothergill Cooke has earned for himself the right to claim the honour of being entitled to stand alone as the gentleman to whom this country is indebted for having practically introduced and carried out the electric telegraph as a useful undertaking."

Next to a four-needle instrument is exhibited the identical "double needles" which led to the capture of John Tawell, the Quaker murderer, on January 1st, 1845. These instruments worked between Paddington and Slough.

The general public had apparently regarded the electric telegraph as a mere novelty until, by its means, a man who had committed a terrible crime was brought to the gallows; and the telegraph was then recognised as an invaluable agent of communication. The messages despatched on that occasion are engraved on brass plates secured to the base of the

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instruments. The inscription on the Paddington instrument is:—

"On January 1st, 1845, the following message was received by this instrument at the Paddington Station:—

'A murder has just been committed at Salt Hill, and the suspected murderer was seen to take a first-class ticket for London by the train which left Slough at 7h. 42m. p.m. He is in the garb of a Quaker, with a brown great coat on, which reaches nearly down to his feet; he is in the last compartment of the second first-class carriage.'

"On January 1st, 1845, the following reply was sent by this instrument from the Paddington Station:—

'The up train has just arrived, and a person answering in every respect the description given by telegraph came out of the compartment mentioned. Pointed the man out to Sergeant Williams. The man got into a New-road omnibus, and Sergeant Williams into the same.'"

Fig. 5 is a drawing of the Paddington instrument. That at Slough was similar.

(TO BE CONTINUED.)

MAGNETO-ELECTRIC MACHINES.

A striking evidence of the interest which is taken by the public in the developments and progress of electrical science, or else of the attention called to the subject by the recent excited speculations in electric light companies, is to be found in the fact that some, at least, of the daily papers begin to treat it as though they realised the fact that it requires special knowledge. *The Times* of 13th June devotes over three columns to a description of some of the leading types of magneto-electric machines, and the description gives clear evidence that its writer knows a great deal of the subject he treats of.

The general description of the principles of electrical generating machines is clear and excellent, and though the general public will not understand it, some leaven of information will, no doubt, be imparted; while the partially-informed and those who have looked at the machines at the Crystal Palace will obtain a fair general comprehension of their principles, especially as to the relations of the two magnetic systems, the field and the armature; also the different purposes and utilities of the continuous and alternating current systems are fairly stated and explained.

The readers, however, require to season the article with a "gramme" or two of salt. It is already very highly seasoned in one direction—it bears an overwhelming flavour of "Gramme." Now, the Gramme machine is an admirable one, and its inventor and its introducers have done a great work in the world and deserve due credit. The principles of the Gramme have served as a ferment to excite further growth, and the scientific mind must recognise that the greater part of the new "systems" so much talked of lately are simply modifications more or less (generally less) important of the Gramme machine. But it is too much to claim that all machines are mere Grammes. That is what those interested in the Gramme are doing, and that claim is even assuming a legal form, and this is what *The Times* article would make people believe. But can any disinterested scientific man uphold such distinct statements as this:—"The Brush machine has a Gramme ring;" or this other as to De Meritens's machine, "It has five Gramme rings." It is, of course, probable that the Gramme ring, or more correctly the Pacinotti ring, did furnish a suggestion in both cases, but as a scientific fact neither the Brush nor the De Meritens ring armatures have any relationship to the Gramme.

Some time ago there arose a partial discussion as to what the essential feature of the Gramme machine is. We were informed by Mr. Werdermann that there was a fundamental distinction between the Pacinotti ring and the Gramme ring, and that any one could use the Pacinotti unquestioned by those concerned in the Gramme patents. The distinction then stated was one as to which the writer possessed some personal knowledge; however, it was this, that the Pacinotti ring was a solid one, and the Gramme ring was composed of coiled up wire. Now, adopting this distinction, the Brush ring may be, in fact clearly is, an improved Pacinotti ring as to its core, and as clearly it is *not* a Gramme ring, and as to its coils of wire it is neither a Pacinotti nor a Gramme ring, but one based upon entirely different electrical principles.

As to the De Meritens, it no doubt arose in the mind of the inventor from considering the Alliance and Gramme machines. But though the form is a ring *apparently*, and it therefore might be fathered by the Gramme, its true scientific parentage has nothing to do with the Gramme. It is in scientific truth *not a ring at all*, but a series of independent electro-magnets. The ring form is a mechanical matter. It is very evident that if we mount a number of radial electro-magnets upon a revolving shaft, acted upon by surrounding N and S magnetic poles, this is in no sense a Gramme ring. Now, De Meritens's ring is simply that identical thing with the middles of the horseshoes disconnected from the shaft, then straightened out and formed into a circle in which the separate ends are brought together and the arrangement of the wires suited to the consequent polar order set up by the action of the external magnets.

In like manner, though the distinction between the Gramme and Siemens armature is fairly stated, it is remarked "that all that we have said of the iron ring in the Gramme machine is equally applicable to this machine," and the wording of the description of the commutator would certainly lead ordinary readers to suppose that it and its action are "precisely as in the Gramme machine." But the fact is that, though there are resemblances, the action of the ring is very different, and the commutator is based upon wholly different principles, as also it is in the Brush.

The Bürgin machine is fairly described with a strong dash of this prevailing flavour, and then after the description of all the machines a distinct paragraph is devoted to the remark, "All these machines employ the Gramme ring." A scientific critic, as distinguished from an engineering one, might object to the statement that "the most peculiar modification of the Siemens armature is that which has been introduced by Mr. Edison." He might possibly enquire what the modification is beyond some mechanical engineering matters of details of construction.

While the description of the machines is marked by accuracy, qualified by the prevailing tone of mind, there is one serious misstatement of fact. In describing their actions as electromotors it is said, "If the current supplied to the machine is in the same direction as that which the machine would produce in working forwards, the machine will be driven backwards. To drive it forwards we must supply it with a current opposite to that which its forward motion would produce." This is true only when the field magnets are permanent ones. The statement is incorrect as to machines with electro magnetic field systems. In these the motion will be in the same direction, whatever the direction of the current. In fact, the field magnets assume polarity according to the direction of the current, and so does the armature, but these being always opposite, whatever the current, the direction of motion is controlled by the arrangement of the brushes of the commutator, and the mutual reactions of the two magnetic systems. In fact, a ring armature may be considered as representing at any moment a bar magnet suspended between the poles of a horseshoe magnet, whose attractions compel it to move in one direction. Now, if we reverse the polarities of both bar and horseshoe, it is evident we leave the direction of the attractions, and the consequent motion, unaffected. If we wish to obtain reverse motion we must reverse only one of the magnetic systems (of course the ring) as is the case where permanent magnets form the field.

THE EDISON LAMPS IN BRAZIL.—The *Rio News*, of Rio de Janeiro, Brazil, says that the experiments with the Edison electric light at the Dom Pedro II. Station in that city are resulting very satisfactorily. The electricity is supplied by a Gramme machine.

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THE TELEPHONE CASE.

(CONCLUDED FROM PAGE 82.)

Professor SILVANUS THOMPSON when recalled gave the following answers to the questions asked :—

Q. Will good conductors make a tension regulator ?—A. Yes.

Q. How ?—A. You only want two good conductors brought into contact lightly, so that there is what one may call light contact between them, and exposed to vibrations of the voice, and you will have a perfect tension regulator, simply because the resistance of two perfect conductors in contact with one another may be made to vary from a resistance which is very great indeed down to a resistance of a small fraction of an ohm. I can quote Sir William Thomson's words he uttered in this box.

Mr. Justice FRY : I suppose practically you agree with the view presented, that it is more convenient to have a substance of low conductivity than of high ?—A. Not necessarily in itself.

Q. I said practically.—A. No ; in the Hunnings transmitter we try to get the best conducting carbon we can, the oven-made engine-coke.

Q. You would not put silver to it ?—A. For quite other reasons.

Q. Would you say practically it is convenient to have a high conducting substance ?—A. I prefer a high conducting substance, others being the same. If you wish to know the reason why everybody pefers some form of carbon for tension regulators, it is not because carbon is a semi-conductor, it is simply because carbon does not melt at the point where the current is running through the contact, for the very same reason that plumbago was used in the relay that the points should not stick, and for that very same reason I believe it to be, carbon is found in one form or other to be the best working substance in the tension regulator ; and once get a substance which, like carbon, does not fuse at the point of contact, then for the Hunnings transmitter give us the best conductor possible, and the best conducting kind of carbon is the one that suits us best.

Q. That is, after all, but a poor conductor ?—A. It is not so very far behind platinum—it is many millions of times better than the lampblack. I have here two specimens of carbon, one in a tube, and the other a rod. This is a rod of coke, artificial gas coke, used for producing the electric light. This is a tube, the internal dimensions and length being, as near as possible, the same, filled with what we call the best quality of lampblack, bought at an ordinary shop. I measured the resistance of this myself. I have had this measured—for the resistance of it was far too high for any appliance I had at Bristol—at Muirhead's, and this resists the passage of electricity about 160 million times as much as this piece of carbon. I would not like to take a shock from a large Leyden jar by this rod because it would knock me down. I should not object to approach any electrical machine with this rod of lampblack, because lampblack is practically a non-conductor. I may make the illustration a little more perfect. Suppose I were working one of those little incandescent Swan lamps, and I were to interpose in the path of the current this rod of carbon, it would go through, and you would not see a perceptible difference in the brilliancy of the light, but to get enough current to make a Swan lamp work through with this, you would have to take one of the largest dynanomical machines at the Crystal Palace—to take about 2,000 of those machines, and set them one after another to drive a current through, so enormous is the resistance of this tube of lampblack. I should be correct in saying more electricity will creep along the moisture of the glass outside than will slip through the carbon inside. Lampblack is practically a non-conductor for all electrical purposes.

Mr. PEARSON : Could you work lampblack in the Hunnings instrument with batteries of the same power which you work Hunnings's instruments with for practical purposes ?—A. Certainly not.

Q. Can you give me at all the difference of power you would require, if even any amount of power would enable you to work it ?—A. I could not get in Hunnings's transmitter what I consider any practical result at all even with an enormous power—with a very great battery power, that I might test the thing fairly.

Dr. ALEXANDER MUIRHEAD stated that he knew the number of the "Zeitschrift" containing the paper by Legat on the reproduction of sound ; that he saw the volume about the middle of 1876 in the Patent Office Library.

Mr. LADD, who described the Reis instrument at the British Association at Newcastle in 1863, testified to the following description of the instrument :—

"This instrument consists essentially of two distinct pieces of apparatus. That for transmitting the signal has a small mouthpiece. On the right-hand side there is a finger-key forming part of the circuit, and an electro-magnet with a vibrating armature and binding screw to connect with one of the line wires. Within a case under a glass cover is an elastic membrane, in the centre of which is fixed a platinum plate in connection with the finger-key. A light angular piece of metal resting on three pins is so placed that the pin at the angle rests on the plate in the centre of the membrane ; " that is, at the apex of the triangle ?

Q. "The other two resting in cups on its edge, so as to allow of free motion on the points. In the body of the receiver-box is suspended a soft iron core, surrounded by a coil of silk-covered wire, one end of which is in connection with the finger-key, and the other with the binding-screw. The method of producing sound in the receiving instrument depends upon the fact that at the moment of magnetising or demagnetising a piece of iron there is an alteration in the arrangement of the particles, which gives rise to a slight ticking noise. Having connected the transmitter by means of an insulated wire with the receiver, and the binding-screws having been brought in connection with the battery of three or four elements, if the finger-key on the transmitter be pressed, the person at the receiving-station hears the ticking noise. To convey a musical note or sound, the operator places his mouth to the tube in front of the instrument and sings a note, when immediately the membrane begins vibrating in accordance with the note sounded, and at each vibration breaks contact between the pin and plate in its centre." That is a proper description ?—A. Yes, it is.

Q. "This forming part of the circuit causes the iron core in the receiving instruments to be magnetised and demagnetised a number of times equal to the number of vibrations of the membrane, and so conveys to the receiver an impression of a musical sound. The finger keys and small magnet at the sides of the instruments are for the purpose of varying the methods of communication by the combination of single sounds, and can also be used with the other parts for the purpose of regulating the lengths of the notes and dividing them into varying portions, so as to form a sound alphabet somewhat similar to the signals written by Morse's telegraph." That is a proper description ?—A. Yes.

After Professor Dolbear, Mr. M. W. Dunscombe, Dr. Stone and others had been examined came the examination of Professor W. E. BARRETT, which contains information on quite a number of experiments. He showed that a Morse sounder would speak loudly and plainly; that the Glasgow instrument would speak with any metal across it, such as a saw or a knife, which was tried. In reply to the question whether he had written about the Reis instrument, Professor Barrett said :—I have written a great many papers from time to time on the Reis instrument. I have taken the general view of scientific men at the time, the popular view, that it was a make and break instrument. As such it was generally regarded until the experiments were made first of all by Mr. Yeates in Dublin, and attention was turned to the fact that broken snatches of words could be transmitted, and this I confirmed by frequent experiments, and found subsequently that Reis mentioned exactly the same thing. I have not thought it necessary to modify the view that I held as to the mere make and break in the Reis, and although, popularly speaking, if you speak loudly into it it is make and break, I find, if you speak very gently, there would be no make and break. The discovery made by Mr. Edison, and, indeed, I may say, the discoveries made by Bell and Gray, would all of them, taken together, lead me to modify my views of the Reis, and in a paper published some time ago I stated when speaking gently the Reis undoubtedly acts according to the same principle as the tension-regulator in Edison's patent.

Mr. Justice FRY : When was that announcement made by you ?—A. Comparatively recently; it is reprinted in the *Electrician* last week, I believe.

Q. Is your conclusion made this year ?—A. Oh, no, about three years ago, since the discovery of Edison, since they were both made known. Since I became acquainted with Edison's carbon telephone I went back to Reis, and found in that telephone an explanation of the words which I heard which always puzzled me, although I had a clear information in my paper of the make and break instrument. I do not read German, and I had Reis's paper translated, and he mentions the transmission of speech, and how the speech could only be transmitted. It is rather technical, but I may be allowed to explain it. A musical note varies only in the pitch, in length of the wave, or in the amplitude of the wave. A make and break instrument can only transmit the speech—the varying length of wave ; but the quality of the voice in speaking, or a compound tone, can only be transmitted by the closed circuit, inasmuch as it depends on the form of the wave, not the amplitude or the length of the wave, but the peculiar form. The particles there are oscillating in one direction and back again ; and Reis does transmit the form of the wave, and I find the inventor of the instrument had even mentioned this in his paper that compound tones could be transmitted ; he recognises the scientific principle of the instrument

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very much more clearly, I think, than people did in England afterwards.

Prof. Barrett in his evidence concerning tension-regulators said that he had heard a couple of sixpences speak beautifully in the plate transmitter, taking out the carbon buttons and putting in the silver, also with a button of silver highly polished, also with nickel. Carbon is used, however, because metals fuse at the points of contact. He also described an experiment with coke particles sprinkled on a gridiron, and a wire electrode embedded in putty thus:—"This is an experiment with the object of ascertaining whether speech could be transmitted without anything resembling a tympan—even using the word in the most liberal sense. I bedded in putty a series of copper wires, and by the side of them another set of copper wires, making them together into a gridiron, fastening the whole firmly down, and sprinkling on the top some of this Hunnings powdered gas coke. I then spoke to this arrangement, and an assistant in a different room listened and told me heard. Then we changed places, and I heard him, so that speech could be transmitted with perfect distinctness by this arrangement. I may add that I supported the base of this on three little knobs of putty to insulate it as far as possible from the table on which the whole thing rested."

Another experiment was thus described:—"I had the following arrangement made. It is a ring of brass very like the electrode on the putty, mounted in an ebonite case, and a sheet of horn placed in front, and another sheet of horn placed behind between the two which are one-quarter or one-eighth of an inch thick. The coke is placed, and speaking on this the speech was transmitted with marvellous fidelity and loudness. Here the electrodes are at right angles to the direction of the sound of the waves, at right angles to the ordinary direction. Then pinching the horn on each side with the fingers so as to stop any tympanic action possible, still speech was transmitted. Putting two little cocks in the centre of each horn-electrode, and screwing it up tightly in a vice and then speaking to it, still speech was transmitted, only more faintly—the particles were then being squeezed too tightly together. Then I removed the horn and placed muslin, everything else being exactly the same. With this arrangement the most admirable transmission of speech was obtained. I do not know that anyone can wish for a better transmitter than a pair of muslin surfaces with gas coke between an electrode and solid plates of glass bedded in the ebonite case. . . . . As it might be urged, possibly, that some tympanic action reached the electrodes through the ebonite case, I removed the semi-circular piece of brass, and hung down two strips of this platinum foil attached to the one end only. Here is the one strip attached to the one binding screw, and the other strip attached to the other binding screw, fixed only at one end, and speaking into this also the most beautiful transmission of speech was obtained, the electrodes in no sense being attached to the horn-sheathing here, quite free as you can see, shaping about. Perhaps the most beautiful that I have ever obtained was by using gelatine sides arranged in the same way as the horn."

An experiment with apparatus as in Edison's patent was thus tried:—"I took an ordinary Edison carbon transmitter, and adjusted the buttons to get good speaking. I then removed the buttons, after testing the perfection of the instrument, and put two circular electrodes round the button, precisely analogous to the gelatine transmitter. I then again put the parts of the instrument together exactly as they were before, only leaving out the electrodes that Edison put in. With this arrangement no speaking can be heard, however careful the adjustment may be."

The conclusion of Professor Barrett is, "That in using the Edison carbon transmitter you must have a tympan and screw adjustment, and an electrode above and below the button to work well; if you alter any one of those parts you spoil the working. If you move the tympan and have only the electrode above and below you have no means of adjustment, and consequently it cannot speak well. If you leave the tympan and move the electrodes, passing them round the button in this form, and then adjust them as before, you will have no speaking, simply because you have not the means of adjustment. There is no possibility of talking through this carbon. There is a carbon telephone in all respects the same as Edison's, only with electrodes hopelessly bad."

Professor W. E. Ayrton in his evidence gave the results of experiments on resistances, which are interesting.

Q. Tell us the results of the resistances of the different substances on which you experimented.—A. There are many substances, therefore I will only take a few. I have taken Hunnings's coke in a solid state, powdered, with definite pressure. The moment you deal with powders, and speak of their resistance, it is necessary to specify—if the result is to have any scientific value —what pressure per square inch is exercised on the powder during the experiment; therefore, in these results the pressure per square inch has been specified. The results are compared with silver and copper, the resistance of which, of course, is well known.

Q. What does silver come out on the standard you are using for your comparison?—A. I put down silver as 1·6, that being a resistance of a cubic centimetre, the size I was adopting for my experiments.

Q. What is the resistance of Hunnings's coke in this solid form on the same scale?—A. About 80,000.

Q. This is resistance, not conductivity?—A. It has to be remembered the substance is very porous; indeed, when you speak of an absolute cubic centimetre of this as an internal volume, it has really not got so much volume, because there are many holes. If the substance were in a more compressed state, solid and fewer holes, the resistance would be less. When you talk of a cubic centimetre of silver, you mean solid silver, not spongy; whereas, you deal here with a substance filled with holes of a considerable size.

Q. Did you try Hunnings's coke in a powdered state?—A. Yes; under various pressures, and under pressure of 14lb. to the square inch it is about 246,000.

Q. Fine powder, or powder such as Hunnings uses in his transmitter?—A. It was a finer powder than Hunnings used in his transmitter; and, therefore, the resistance under the same pressure undoubtedly is considerably more than one would have obtained if he took the powder that he uses. I wished to get the two classes of gas coke from the solid block, and as fine powder as a pestle and mortar could reduce it to.

Q. Can you draw any inference from those two experiments as to the limits within which the resistance of Hunnings's coke, as he uses it, must be taken?—A. I think the resistance might be taken as between solid and extremely fine powder.

Q. It would be between the two?—A. Yes, I believe so.

Q. The resistance of Hunnings's coke, as he uses it, would be between 80,000 and 240,000?—A. Yes.

Q. Did you try Edison's in the solid state?—A. Yes.

Q. What did that come out?—A. In the solid state it comes out about 558,000; that is about twice the resistance of Hunnings's coke powdered.

Q. Now, did you try Edison's button powdered?—A. I have also tried that powdered, that is, about one hundred and twenty-two millions, with a pressure of 7¾lb. per square inch.

Q. Did you try any specimen of lampblack?—A. I have tried several specimens of lampblack.

Q. Tell us where you got them, and what the results were.—A. Some specimens were got from Burgoyne and Burbage, well-known chemists, and I have also experimented on the same specimen of lampblack that Professor Barrett used, bought in London, because it was very desirable we should know the real resistance of the specimens he bought in the way he described to you. He bought some at 68, Farringdon-street, and elsewhere. I have tried all the specimens Professor Barrett sent me.

Q. Can you identify those?—A. I have tried superior lampblack, No. 4.

Q. Give us the superior lampblack.—A. Superior lampblack, No. 4, under a pressure of 14lb. per square inch, is 542 million millions. That is about two million times the resistance of powdered Hunnings coke. Where we are dealing with substances like gutta percha and india rubber, we are accustomed to many millions of millions of resistance.

Mr. Justice Fry: Why is it you have subjected the different materials to different modes of pressure?—A. Of many of them I have taken a set of pressures. For example, the lampblack I now refer to, the superior lampblack, I have tried altering the pressure from 4lbs. per square inch to 14lbs. per square inch. I am only here giving the results of one or two of the experiments made with each substance. In reality, I made a more or less complete experiment with each substance; for instance, the lampblack No. 4 diminished its resistance only from 8 to 5—that is, from 800 million millions to 500 million millions—and the pressure was increased from about 4lbs. to 14lbs. per square inch. On the other hand, I found Hunnings's coke in a finely powdered condition diminished its resistance from 80,000, the original resistance, to 20,000 when the pressure was only increased from 8 to 14—that is to say, not only did I find the Hunnings coke has a resistance of about a two thousand millionth part of the resistance of this lampblack, but I found under a less variation of pressure a far greater change in the resistance, Hunnings's coke varying from 80,000 to 20,000, that is, reduced to about one-fourth when the pressure was changed from 8 to 14lbs.

Mr. Hemming: To take another specimen, the Burgoyne and Burbage sample you got yourself, did you get a result as to the resistance?—A. The resistance of that was 191,000 millions compared with silver at 8¾lb. per square inch, and 174,000 millions under a pressure of 15.

Q. Roughly, about a million times; something like a million times the Hunnings coke?—A. About a million times.

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Q. The other lampblack was 2,000 million times the resistance?—A. The resistance of powdered Hunnings coke.

Q. Among all the specimens you tried, are these the highest and lowest, these two you mentioned—the Burgoyne and Burbage at 191,000 millions, and the superior lampblack?—A. I tried another specimen. I tried best lampblack, bought at 68, Farringdon-street.

Q. Was that lower or higher?—A. Higher.

Q. Is this 191,000 millions the lowest?—A. The lowest lampblack I have come across.

Q. In the other, 543 million millions was the highest?—A. Not the highest.

Q. Have you one higher?—A. The best lampblack, bought at 78, Farringdon-street, had a million million times 1,150,000. The figures are so large that one is liable to get into confusion. It is 1,150,000 million times the resistance of silver, 1,150 million million times.

Q. That I make about upwards of 4,000 million times the resistance of Hunnings coke?—A. Taking the powdered coke of course.

Q. It is something intermediate between the two. You made many other experiments on other substances?—A. I made many other experiments on other substances.

Q. Which you will be happy to give my friends if they want. Just tell me this, because there is a difference of opinion about it, whereabouts does platinum come?—A. Platinum is about six times the resistance of silver.

Q. What is the number?—A. 9·2.

Q. What is iron?—A. About 9·8. I made an experiment which was interesting on amorphous phosphorous, I took that because it was mentioned by Edison. I bought that from Hopkins and Williams, the distinguished chemists, and I found it to be a million million times the resistance of silver.

Q. You know what the Hunnings transmitter is, and you know what the Edison transmitter is? In your judgment does Hunnings's transmitter contain a combination of a tympan or diaphragm with a tension regulator.—A. No, certainly not. I consider that the tympanum is essentially absent from the Hunnings transmitter. I do not consider the platinum foil at all takes the place of an acoustic tympanum.

Q. Have you any experience of the use of substances of different degrees of conductivity in the transmitter—have you compared the action of substances of different degrees of conductivity in the transmitter?—A. I have listened to receivers when various transmitters have been employed.

Q. What is the substance of highest conductivity you have tried—have you tried any of the metals?—A. I have heard, I cannot say I have tried, because I did not make the experiments. I have seen experiments made by others, and I have heard two pieces of silver used in the transmitter, and I certainly understood the words spoken—given out by the receiver. That is the substance of the highest conductivity and lowest resistance.

Mr. H. S. Eaton, librarian of the Institute of Civil Engineers, and Dr. Hopkinson, gave further evidence, when the case, so far as evidence is concerned, concluded, the result being as given in the decision of Mr. Justice Fry, which has been fully printed in a previous number.

PHYSICAL SOCIETY.—June 10.

Professor Clifton, President, in the Chair.

Mr. W. F. Stanley read a paper on "Sonorous Vibrations," especially those of the tuning fork. The larger and more visible movements of a sounding body do not appear to be best fitted to propagate musical sounds, as was shown by placing discs on the prongs of a powerful fork, which, when vibrating, could then only be heard a short distance; whereas, by its smaller longitudinal motions when placed on its resonator it produced a penetrating sound. The vibration down the stem of the fork was shown not to depend upon a vibrating ventroid as suggested by Chladni, for a fork cut in the end of a solid steel bar communicated sonorous vibrations equally well to the resonator. To set a fork in vibration it was necessary to bow one prong only, therefore in this case the vibration must proceed along the prongs. A light fork one metre long was fixed in a heavy vice, and it was shown by it that vibrations passed down one prong and up the other alternately. By means of dust ripples were shown to run down an ordinary fork in vibration. Light pieces of metal were fitted to the ends of a powerful fork, and these immersed in mercury, the reflected surface of which was shown on a screen, where it was seen that the whole mercury surface was broken into fine ripples. It was suggested that such small waves are also perceived by the ear. By these certain conditions of harmonies could be better accounted for, as, for example, by division in smaller waves the rarefaction of a note in space would not suffer interference by the condensation of the octave falling in the same space and time.

Lord Rayleigh explained several of Mr. Stanley's experiments on the known theory of sound.

Mr. Walter Baily then exhibited a model of a new "integrating anemometer." This apparatus contains a horizontal plane, in which are two slits forming a cross with arms towards the cardinal points. Each slit is fitted with a sliding piece, and the two slides are connected by a bar, the arrangement being that of the well-known instrument for drawing ellipses. The slides carry beneath them wheels with their planes perpendicular to the slits, and passing through the pivots of the bar. The wheels rest on a horizontal disc whose centre is beneath the centre of the cross. The centre of the bar is to be connected to a weathercock which will keep it in the direction of the wind when looked at from the centre of the instrument. The disc is to be revolved by Robinson's cups. The number of revolutions of the wheels then give the integral of the resolved parts of the wind in the direction of the cardinal points. In the working model of the instrument exhibited there was an electrical arrangement connected with four indicators, one for each of the cardinal points. At each turn of a wheel a current was completed, and the corresponding indicator moved. The cording instruments are to be substituted for indicators, and the amount recorded on each in a given time will be proportional to the total motion of the wind towards the corresponding cardinal point.

Mr. Lecky pointed out that a good anemometer was a great desideratum at present.

The society meets at Oxford on the 17th, and South Kensington on the 24th of this month.

GREAT WESTERN ELECTRIC LIGHT AND POWER COMPANY.

An extraordinary meeting of the shareholders of this Company was held on Wednesday at the Cannon-street Hotel. Mr. H. B. Evans in the chair.

The Chairman explained that the meeting had been called for the purpose of confirming the resolutions passed at the meeting of the Company held on the 30th of May last. The resolutions referred to had reference to the Articles of Association of the Company, and they were asked to pass them in compliance with the Stock Exchange regulations before they would be granted a settlement and quotations. The resolutions were carried, and the proceedings closed.

The first general meeting of the Company was then held, Mr. Evans again presiding.

The Chairman said they had not allotted many shares up to the present. They had sold the concession of Devon and Cornwall for the sum of £15,000. Negotiations were pending with regard to the opening of a central station at Bristol. They had absolutely secured a central station at Cardiff, where operations will at once be commenced. There was also promise at Newport. He believed they would soon be doing a considerable business in other towns. The future prospects of the Company were of a most favourable character, and he had no doubt that the electric light would be the illuminator of the future.—The proceedings then terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices June 14.		Business Done Week Ending June 14. Highest.	Lowest
Anglo-American	54,	55	54¼	51⅝
Do. Preferred	85,	86	86	83½
Do. Deferred	23½,	24½	24¼	22½
Brazil Submarine	11⅜,	11⅝	11⅝	11⅜
Cuba	9¾,	10¼	9 13-16	9 13-16
Do. Preference	16,	17	—	—
Direct Spanish	6¼,	6¾	6½	6½
Do. Preference	15½,	16½	—	—
Direct United States Cable	12⅛,	12⅜	12¼	11⅞
Eastern Telegraph	10⅝,	10⅞	10⅝	10½
Do. 6 per Cent. Preference	13,	13½	13¼	13
Do. 5 per Cent. Debentures, 1899	102,	107	—	—
Eastern Extension	11½,	11¾	11⅝	11 9-16
German Union	9¾,	10¼	6½	6 7-16
Globe Telegraph and Trust Company.	6⅝,	6⅞	6¾	6⅝
Do. Preference	12¼,	12¾	12⅝	12½
Great Northern	12¾,	13¼	13¼	12 15-16
Indo-European	28,	29	—	—
Mediterranean Extension	2,	2½	—	—
Do. Preference	8½,	9	—	—
Reuter's	12¾,	13¼	—	—
Submarine	265,	275	—	—
West India and Panama	1¾,	2	1 13-16	1 13-16
Do. 1st Preference	8½,	9	8½	8½
Western Brazilian	7¼	7¾	—	—
West. Union 7 per Cent. 1st Mortgage	121,	126	—	—
Do. 6 per Cent. Sterling Bonds	102,	105	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1¾,	2	1 15-16	1 11-16
Oriental	½,	¾	9-16	9-16
United Telephone	14,	14½	14¼	14

ELECTRIC LIGHT.

Electric Light and Power	¾,	1¼	1 1-16	15-16
Anglo-American Brush	22,	23	23½	20½
Eastern Electric	4¼,	4¾	4⅝	4⅜

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BRUSH AND LANE-FOX SYSTEMS.

THE ANGLO-AUSTRIAN BRUSH ELECTRICAL COMPANY, LIMITED.

Incorporated under the Companies' Acts, 1862 *to* 1880.

THE LIABILITY OF SHAREHOLDERS IS LIMITED TO THE AMOUNT OF THEIR SHARES.

CAPITAL £500,000. First Issue, £300,000, in 60,000 Shares of £5 each,

OF WHICH 40,000 SHARES ARE OFFERED FOR SUBSCRIPTION.

Payments—10s. per Share on Application, £1 per Share on Allotment, £1 per Share on the 1st September, 1882, and the balance as required, in calls not exceeding £1 per Share, subject to 30 days' notice.

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The Hon. ARTHUR SAUMAREZ, 17, Grosvenor-gardens, S.W.
Lieut.-Colonel R. W. HAMILTON, 1, Cadogan-square, S.W.
Sir A. F. A. SLADE, Bart., 3, Lyall-street, Belgrave-square, S.W.
GEORGE BADEN-POWELL, Esq., M.A., F.R.A.S., F.S.S., 8, St. George's-place, Hyde Park Corner, S.W.
St. GEORGE LANE-FOX, Esq. (Patentee of the Lane-Fox System), Queen Anne's-mansions, Westminster, S.W.
C. DE KIERZKOWSKI-STEUART, Esq., Memb. Inst. C.E. (Engineer and Representative of the Anglo-American Brush Electric Light Corporation at the Paris Exhibition, 1881), 7, Collingham-road, Cromwell-road, S.W.
(With power to add to their number.)

ELECTRICIAN.

CHARLES H. BENTON, Esq., lately Electrician in the "Brush Electric Company," of Cleveland, Ohio, U.S.

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SECRETARY (pro tem.).
MIALL FRASER, Esq.

OFFICES.
4, COPTHALL BUILDINGS, BANK, E.C.

PROSPECTUS.

This Company is formed for the purpose of manufacturing, working and supplying in Austria, Hungary and Roumania, apparatus for the application of electricity, and of promoting local companies or associations for working the same.

The Company has contracted with M. de Kierzkowski-Steuart for the purchase of the following patents and advantages, viz.:—

(a) All the patents of the Anglo-American Brush Electric Light Corporation (Limited), for the Austrian Empire and for the Kingdom of Hungary, for the inventions of Charles Francis Brush and St. George Lane-Fox, which patents are seven in number, and are respectively dated and numbered as follows:—

17th Oct., 1880.	No. 26940.
Do. do.	No. 28093.
11th Nov., 1881.	No. 25919.
17th Nov., 1881.	No. 32090.
Do. do.	No. 32091.
18th Nov., 1881.	No. 27605.
29th Jan., 1882.	No. 40625.

(b) All improvements in the above-mentioned inventions to which the Anglo-American Brush Electric Light Corporation (Limited) may be entitled under their now existing agreements with Charles Francis Brush and St. George Lane-Fox respectively.

(c) The engagement of the Anglo-American Brush Electric Light Corporation not to sell, make, or use in Roumania any of the inventions the subject of the respective patents so long as the same or any extension thereof remain in force.

It is needless to dwell on the merits and commercial value of the "Brush" patents, which have been amply proved by the extraordinary financial success of the Brush Electric Company of Cleveland, Ohio, U.S. (now of several years standing), and of the Anglo-American Brush Electric Light Corporation (Limited) of London.

The Lane-Fox patents comprise the well-known system of lighting by incandescence and a new and complete system of distribution, utilising the principle of storage.

The Company will thus be enabled to undertake for all purposes indoor and outdoor lighting.

The price of gas is known to be much higher in Austria than in England. Thus the Company may look for great advantage in respect of competition with gas.

The Anglo-Austrian Brush Electrical Company will possess, not mere licences, but the absolute property of the "Brush" patents for Austria-Hungary, and will be in a position to achieve in those countries what the Companies above referred to have done in the United States and in England.

The field of operations in respect of which rights have been secured is of vast extent. The Austro-Hungarian Empire has an area of 250,000 square miles, and a population of over 37¾ millions. Amongst the principal cities and towns are Vienna with 1,028,000 inhabitants, Budapest 271,000, Prague 190,000, Trieste 109,000, Lemberg 87,000, Gratz 82,000, Brünn 74,000, Presburg 47,000, and a very large number of smaller towns with populations of 40,000 and less.

As regards Roumania, the Anglo-American Brush Electric Light Corporation is precluded by the agreement with the Vendor from carrying on its business there. The population of the Kingdom of Roumania is over 5,073,000; and amongst the principal towns are Bucarest with 222,000 inhabitants; Jassy with 90,000; Galatz with 80,700.

It is proposed to take immediate steps for the formation or promotion of local Companies for the purchase and working of licences for the lighting of the above-mentioned and other towns and districts, and for the introduction of other applications of electricty. It is also intended forthwith to erect works or make other arrangements for the manufacture in the Austrian Empire of the electrical apparatus which will be required by the subsidiary Companies and by the public

These measures will be in accordance with the policy so successfully pursued by the American and the English parent Companies.

It is important to note that the Company will by these arrangements remain in possession of the business of manufacture (a business which in other countries has proved highly lucrative) after creating by the sale of licences a large market for the apparatus manufactured. Some notion of the probable profits of the Company may be formed from the last published balance sheet of the Anglo-American Brush Electric Light Corporation (Limited), which on a paid-up Capital of £238,006 showed a profit for the first year of £134,965 6s. 1d., out of which the whole of the expenses of formation of the Company were paid, and a dividend of 12½ per cent. was declared; 10 per cent. was written off for depreciation of plant and machinery; £99,500 was carried to reserve fund, and the balance of £2,934 18s. 9d. was carried forward.

The agreement with the Vendor provides that pending arrangements being made to manufacture in Austria the Anglo-American Brush Electric Light Corporation are to supply the patented apparatus at a discount of 20 per cent. on their tariff prices.

The Vendor has procured the first subscription of 12,000 shares of the Company. 8,000 shares are taken by him in part payment of the consideration money, as hereinafter appears. The remainder (being two-thirds of the present issue), viz., 40,000 shares, are offered to the public.

The Vendor has undertaken to pay all expenses attending the formation of the Company, up to the allotment of shares, excluding only brokers' fees.

As consideration for the transfer to the Company of the patents above referred to, and the benefit of his agreement with the Anglo-American Brush Electric Light Corporation, and for his services in the formation of the Company, and the subscription of the Capital, the Vendor is to receive £55,000 in cash and 8,000 ordinary shares, with £2 10s. per share credited as paid up thereon.

The only contract entered into by the Company is dated 12th June, 1882, and is made between C. de Kierzkowski-Steuart of the one part, and the Anglo-Austrian Brush Electrical Company (Limited) of the other part.

The contract entered into by C. de Kierzkowski-Steuart with the Anglo-American Brush Electric Light Corporation (Limited) is dated 31st May, 1882. It states that on the 13th day of May, 1882, the said C. de Kierzkowski-Steuart paid to the Anglo-American Brush Electric Light Corporation (Limited) the sum of £11,000 by way of deposit, and in part payment of the sum of £44,000, being the price agreed to be paid by him on or before the 22nd of July, 1882, for the patents and other rights now agreed to be transferred to this Company, and that in default thereof such payment of £11,000 should be absolutely forfeited.

The Articles of Association provide that Mr. C. de Kierzkowski-Steuart, being interested as a vendor to the Company, and Mr. St. George Lane-Fox, having an interest with the Anglo-American Brush Electric Light Corporation in the patents sold, although respectively directors of this Company, shall not vote or take part in any matters relating to the carrying out or modification of the said agreement.

Copies of all the above-named Agreements and of the Memorandum and Articles of Association of the Anglo-Austrian Brush Electrical Company can be inspected at the offices of the Solicitors.

In the event of no allotment being made the deposit on application for shares will be returned in full.

Copies of the prospectus may be obtained on application to the London Bankers, Brokers, Solicitors, or Secretary of the Company.

Applications for Shares must be made on the form accompanying the Prospectus, and must be forwarded to the London Bankers, together with the amount payable on application.

Immediately after allotment a Stock Exchange settlement and quotation will be applied for.

No.

FORM OF APPLICATION FOR SHARES.

TO THE DIRECTORS OF THE

ANGLO-AUSTRIAN BRUSH ELECTRICAL COMPANY (LIMITED).

GENTLEMEN: Having paid to your Bankers the sum of £ , being a deposit of 10s. per Share, I request you to allot me Shares of £5 each in the Company, and I agree to accept such Shares, or any less number that may be allotted to me, upon the terms of the Prospectus, and subject to the Memorandum and Articles of Association of the Company, and I authorise you to place my name on the Register of Members in respect of the Shares allotted to me.

Signature..
Full Name ....
Address ....
Description or Occupation ....
Date , 1882.

EDISON'S INDIAN AND COLONIAL ELECTRIC COMPANY,

LIMITED.

CAPITAL £250,000, in 40,000 A Shares and 10,000 B Shares of £5 each.

Issue of 35,000 A Shares, with 6 per cent. cumulative preferential dividend, and participation in further profits. 11,000 of these Shares have been already applied for, and will be allotted in full.

10*s. per Share payable on Application*, 20*s. per Share payable on Allotment.*

Further calls will be made as required, but it is not anticipated that any call will be made during the next six months.

DIRECTORS.

The Most Hon. the Marquis of TWEEDDALE, Chairman.
The Hon. W. ST. JOHN BRODRICK, M.P., 29, Lower Seymour Street.
HENRY SCHLESINGER, Esq., 5, Kensington Park Gardens (late of the firm of Messrs. Naylor, Benzon, and Co., London, and Messrs. Naylor and Co., U.S.A.).
Colonel the Hon. W. LE POER TRENCH, R.E., 3, Hyde Park Gardens.
Sir GEORGE WARRENDER, Bart., of Lochend, N.B.

CONSULTING ELECTRICIANS.

Mr. THOMAS ALVA EDISON.
Mr. EDWARD H. JOHNSON.

BANKERS.

Messrs. GLYN, MILLS, CURRIE, and CO., 67, Lombard Street, London, E.C.
The COMMERCIAL BANK of SCOTLAND, Edinburgh.

SOLICITORS.

Messrs. BIRCHAM and CO., 26, Austin Friars, London, E.C.

BROKERS.

Messrs. ARTHUR ANDERSON and CO., 30, Throgmorton Street, London, E.C.

SECRETARY (pro tem.).
Mr. CAMERON BROCK.

TEMPORARY OFFICES.
No. 6, LOMBARD STREET, London, E.C.

PROSPECTUS.

This Company has been formed for the purpose of acquiring and using in the Empire of India, Ceylon, Australasia, and South Africa the rights and privileges of Mr. Thomas Alva Edison relating to the application of Electricity or Magnetism as a lighting, heating, or motive agent (except the application thereof for the purpose only of locomotion on railways or tramways or common roads, and except also the right of the Cape Government to use an installation which has been already sent out to them), and for the other objects specified in the Memorandum of Association, a print of which is issued with the Prospectus.

A large number of Patents or Letters of Registration have been obtained by Mr. Edison for India and the Colonies of Victoria, New South Wales, Queensland, and New Zealand, all of which are secured to the Company. Applications for Patents or Registrations have been or will be made in the last-named Colonies, and in South Australia, Tasmania, West Australia, South Africa, and Ceylon, which when obtained will belong to the Company, without any further payment except the cost of making or completing such applications.

In addition to the above, the Company has acquired a most important advantage in the right to patent and use in Australasia, South Africa, India, and Ceylon, all Mr. Edison's improvements which may be made during the term of five years, from the 12th day of June, 1882. No further payment will accrue to Mr. Edison on the Company exercising this right. After the expiration of the term of five years the Company will have the option of acquiring all additions and improvements made and patented by Mr. Edison on payment of such sums as may from time to time be agreed on or fixed by arbitration in case of difference. The only reservation in favour of Mr. Edison is in respect of locomotion on railways, tramways, or roads.

The Edison Incandescent Lamp is unequalled for domestic and general illumination, and is suitable for all places where a steady, brilliant light, obsolutely safe in its production and use, is required. It is peculiarly adapted for India and other tropical countries, as it will be unaffected by Punkahs and wind currents, and emits comparatively little heat. When once fixed it requires no skilled labour, but can be attended to by an ordinary native or other servant.

The Edison System, however, does not merely comprise a particular form of lamp, dynamo or regulator, but is a comprehensive whole, embracing every detail essential to the economical, reliable, and safe production and distribution of Electricity for the innumerable purposes to which it can be applied, whether in connection with light, heat, or motive power. It includes many ingenious and effective devices believed to be peculiar to this system, some of which are referred to in the following extract from a lecture at the Society of Arts, by Mr. W. H. Preece, F.R.S., Electrician to the Post Office, which affords important independent testimony to the above statements.

"The completeness of Mr. Edison's exhibit was certainly the most noteworthy object in the (Paris) Exhibition. Nothing seems to have been forgotten, no detail missed. There we saw not only the boilers, engine, and dynamo-machine, but the pipes to contain the conductors; the conductors themselves, heavy and massive—for Mr. Edison recognises the waste of energy that must occur in small conductors—the insulation, the fixtures, the brackets, the safety catches, the lamps, devices to avoid the effects of expansion and contraction through changes of temperature, meters to measure the current used, regulators to control the consumption of fuel." . . . "Mr. Edison's system has been worked out in detail, with a thoroughness and mastery of the subject that can extract nothing but eulogy from his bitterest opponets. Many unkind things have been said of Mr. Edison and his promises; perhaps no one has been severer in this direction than myself. It is some gratification for me to be able to announce my belief that he has at last solved the problem that he set himself to solve, and to be able to describe to the Society the way in which he has solved it."

The Safety-catch, above referred to, is an invention for preventing danger from fire in case of the conductors generating heat by reason of breakage or other accidental injury.

The system may be seen in full operation on Holborn-viaduct, where the street extending from Holborn-circus to Old-bailey, the City Temple, two hotels, the entrance to the London, Chatham, and Dover Railway Station, Messrs. Spiers and Pond's Restaurant, and numerous shops and offices are lighted up from a Central Station. The Lamps give out very little heat, they may be grasped by the naked hand without danger or inconvenience, are free from odour, and give off no products of a poisonous or noxious character.

This Company, deriving as it does it rights and privileges direct from Mr. Edison, will be a parent Company. It will be prepared to undertake the business of a Lighting and Power Company, by lighting up towns, public buildings, manufactories, barracks, and residences, and supplying power by means of electricity; and in order to enlist local capital and influence will grant licenses to Corporations and local Companies to carry on a similar business.

With a view to the early commencement of active operations the Directors have made arrangements for purchasing a number of Mr. Edison's lamps, dynamos, and other materials which are now in London, ready for shipment to some of the principal centres of population and industry within the Company's field of operations. Mr. Edison has agreed, until 1st January, 1883, to supply the Company with Dynamos, Lamps, and other specialties of his system, of his own manufacture, at the prices charged by him to his most favoured customers. The Company, however, is free to obtain all such things elsewhere, or to manufacture them, whenever it shall be found more advantageous to do so.

The consideration to be paid for the property and rights secured to the Company is the sum of £25,000 in cash, 5,000 A Shares, fully paid and ranking as such for dividend, and 10,000 B Shares, fully paid, upon which no dividend will be paid until after the A Shares have received a cumulative dividend of 6 per cent. per annum. The surplus profits available for dividend, after payment of the 6 per cent. of cumulative dividend on the A Shares will be divided equally between A and B Shares until the A Shares shall have received a dividend equal to 10 per cent. The remaining profits, subject to a percentage payable to the Directors, will then be divided equally between the A and B Shares respectively. No promotion money will be paid.

The Directors are in negotiation for securing the services of an exceptionally competent Manager, who will be prepared to visit India and the Colonies whenever occasion may require.

The only agreement entered into is dated 12th June, 1882, and made between Thomas Alva Edison, of the first part; George Edward Gouraud, of the second part; and the Marquis of Tweeddale, the Honourable W. St. John Brodrick, M.P., Henry Schlesinger, Colonel the Honourable W. Le Poer Trench, and Sir George Warrender, Bart., of the third part, and which is open to inspection (together with the Memorandum and Articles of Association of the Company) at the Offices of Messrs. Bircham and Co., solicitors, 26, Austin Friars, London.

Applications for shares must be made on the form accompanying the Prospectus, to be lodged with Messrs. Glyn, Mills and Co., of 67, Lombard-street, London, E.C., or the Commercial Bank of Scotland, Edinburgh, the Company's Bankers, together with a deposit of 10s. per share. In case of no allotment being made, the amount of deposit will be returned in full. Where a smaller number of shares are allotted than are applied for, the balance of the deposit will be applied towards payment of the amount payable on allotment.

Prospectuses and Forms of Application may be had of the Brokers, Messrs. A. Anderson and Co., 30, Throgmorton-street, E.C., and at the Temporary Offices of the Company, 6, Lombard-street, E.C.

The Subscription List will be closed for London on or before Friday, the 16th inst., and for the Country on or before Saturday, the 17th inst.

12th June, 1882.

FORM OF APPLICATION FOR SHARES.

TO THE DIRECTORS OF

EDISON'S INDIAN AND COLONIAL ELECTRIC COMPANY (LIMITED).

No.

GENTLEMEN: Having paid to your Bankers the sum of £ , being a deposit of 10s. per share, I request you to allot me Shares of £5 each in the Company, and I agree to accept such Shares or any less number that may be allotted to me upon the terms of the Prospectus, dated 12th June, 1882, and the Memorandum and Articles of Association of the Company, and I authorise you to register me as the holder of the Shares allotted to me,

Signature in full ....
Address ....
Description ....
Date June, 1882.

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THE SCHOOL OF TELEGRAPHY & ELECTRICAL ENGINEERING.

ESTABLISHED IN 1868.

12, PRINCES STREET, CORNER OF HANOVER SQUARE, LONDON, W.

(Removed from 4, George Street, Hanover Square.)

MANAGING DIRECTOR: Mr. T. J. JONES, M.S.T.E.

The course of Practical and Theoretical Instruction in the higher branches of Overland and Submarine Telegraphy embraces, in addition to the manipulation of he various systems of working in general use, the following subjects:—

MATHEMATICS,	In relation to Telegraphy.	SIGNALLING and TESTING INSTRUMENTS.	ELECTRO-STATICS.	METHODS of TESTING the ELECTRICAL CONDITION of a LINE During and After its Construction.
MECHANICS, and			ELECTRO-DYNAMICS.	TESTING FOR and LOCALISING FAULTS, &c., &c., &c.
CHEMISTRY,		ENGINEERING FORMULÆ and their Application in Practice.	MAGNETISM.	

The instruction, both in signalling and testing, is of a thoroughly practical character, as the classes work with the actual instruments used on long lines, through cables of various lengths, from 600 to 3,000 knots, so that the signals of the Eastern, Atlantic, and Brazilian Co.'s, &c., are exactly reproduced, and the pupils fitted for any line.

A complete practical and theoretical course of instruction on the TELEPHONE and the ELECTRIC LIGHT, and their commercial utilisation, has now been added to, and embodied in, the ordinary curriculum, as the advantage of being associated with any great commercial application of science at an early period of its development is one which has been so often exemplified that it can scarcely fail to be appreciated by those who have in view professional success.

That **TELEPHONIC** communication and **ELECTRIC LIGHTING** constitute such applications is sufficiently shown by their rapidly increasing progress; and therefore no pains or expense have been spared to place at the disposal of the pupils the technical and scientific instruction requisite to qualify candidates for the most important posts in connection with these new branches of electrical engineering. In order that the instruction in the erection, adjustment, testing, and working of **TELEPHONE** and **ELECTRIC LIGHT** circuits may also be thoroughly practical, complete working telephone exchanges upon the various systems in use in different countries have been fitted up; every kind of telephone, for both exchange systems and private lines, with all apparatus used therewith, is provided (in duplicate when possible, so that students may be able to dissect and reconstruct the same). The necessary tools and materials are available, and every facility is given for conducting experiments by the pupils desirous of so doing, and a similar course is being pursued with the **VARIOUS LAMPS** and **MACHINES**, &c., in the **ELECTRIC LIGHT** Department, so that pupils from the School are in a position to enter either of these new fields.

The complete Practical and Theoretical course extends over a period of Six Months.

Arrangements have been made so that Inventors, Amateurs, and others can now have every facility, with all necessary apparatus provided in private rooms, to compare, test, or perfect any Inventions, Apparatus, &c., connected with Telegraphy, Telephony, and the Electric Light. Financial and the highest professional assistance can also be had.

Further particulars may be obtained on application to W. N. TIDDY, *Secretary.*

THE EXCHANGE TELEGRAPH COMPANY, LIMITED.

Head Offices—17 & 18, Cornhill, E.C.; Stock Exchange, E.C.; 27, Regent Street, W.

Incorporated the 28th March, 1872, under the Companies Acts of 1862 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

Not having any springs or clockwork to wind up or to depend on, these instruments are acknowledged by those familiar with the system of telegraphy to be the only instruments yet invented that are capable of doing the work required of them continuously for a lengthened period, as evidenced by the fact that the Gold and Stock Company of New York, having the monopoly of this kind of business in the States, and which owns all the patents of the day of any value, has, after due trial, discarded all others.

The Company is prepared to treat with provincial Companies requiring instruments for the delivery of news for either single or double wire systems under the Company's patents, whereby from central stations identical information can be simultaneously delivered to any number of recipients by automatic, self-adjusting, printing instruments requiring no local batteries, no winding up, and no knowledge of telegraphy on the part of the receiver, the printing being in bold roman type, and the propulsion of the paper being effected by the electricity supplied from the Central Office.

The instruments supplied by the Company can be had to work either on single or double wires, and to print either on a slip or tape of paper, as has hitherto been the custom, or on a broad band of paper in column form.

RAMSDEN, CAMM AND CO.,

BRIGHOUSE, YORKSHIRE.

IRON and STEEL WIRE DRAWERS and PATENT GALVANIZERS.

MANUFACTURERS OF TELEGRAPH, TELEPHONE, & CABLE WIRE.

CONTRACTORS TO H.M. GOVERNMENT AND RAILWAY COMPANIES.

LONDON OFFICE: 72, KING WILLIAM STREET.

JOURNAL of the SOCIETY of TELEGRAPH ENGINEERS and of ELECTRICIANS.
Edited by Professor AYRTON, F.R.S.
No. 42,
containing Illustrated Papers on

"Tests of Incandescent Lamps for Fall of Resistance with Increase of Electromotive Force, and Ratio of Candle-power to Work done on Lamp," by A. Jamieson.

"Attraction and Repulsion due to Sonorous Vibrations, and a Comparison of the Phenomena with those of Magnetism," by A. Stroh.

"Report on Incandescent Lamps Exhibited at the International Exposition of Electricity, Paris, 1881," communicated by W. Crookes, F.R.S.

Price Three Shillings.

E. and F. N. SPON, Charing-cross.

A PRACTICAL ENGINEER and ELECTRICIAN (Assoc.Mem.I.C.E.) wishes an ENGAGEMENT. Accustomed to both Lighting and Manufacture. Highest references and testimonials.—Address, "D. E. R.," ELECTRICIAN Office.

TO ENGINEERS, ELECTRIC COMPANIES and Others. —A fine MANUFACTURING PROPERTY to be SOLD at a very low price. Close to a station. With possession.—Apply to Messrs. PRIOR and NEWSON, 57, Lincoln's Inn-fields, W.C.

FIRE RISK, &c., of ELECTRIC LIGHTING.
Mr. MUSGRAVE HEAPHY, C.E., Consulting Engineer to the PHŒNIX FIRE OFFICE, can be CONSULTED PROFESSIONALLY by all who contemplate using the Electric Light.

Mr. Heaphy will advise as to the most suitable and economical light, supervise the estimates furnished by the Electric Light Companies, superintend the installation and all matters connected therewith, giving special attention to Fire Risk and Danger.

Address—19, LOMBARD-STREET, LONDON, E.C.

P.S.—For Account of Mr. Heaphy's Report upon Electric Lighting and Rules necessary for Safety see "Times," May 10th; "Electrician," May 13th; "Journal Soc. of Arts," May 5th; "Insurance Guardian," April 26th; and most of the leading papers in England.

LIFE ASSOCIATION of SCOTLAND.
Founded 1838.
HEALTHY PERSONS OF ALL AGES will find in the BONUS SYSTEMS of the LIFE ASSOCIATION of SCOTLAND advantages far exceeding those which can be obtained under any of the ordinary systems.

Claims and Bonuses paid £4,028,000
Annual Revenue 436,000

Immediate Entrants in Class A will secure ONE YEAR'S BONUS MORE THAN LATER ASSURERS in that class.

LONDON—5, Lombard-street, and 48, Pall Mall.
EDINBURGH—82, Princes-street.

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SLIP

AN ELECTRIC RAILWAY FOR PHILADELPHIA.—A narrow-gauge electric railway in Fairmount Park, Philadelphia, is proposed.

ELECTRIC RAILWAYS.—Dr. Siemens is to give a lecture on this subject in Trinity College, Dublin, on Monday next, at four o'clock.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company, for the week ending the 9th inst., amounted to £3,301.

TELEGRAPH WIRES IN ENGLAND.—According to recent statistics there are, on an average, four miles and a half of wire to every mile of telegraph line in England.

SOUTH AFRICAN TELEGRAPHS.—The telegraph receipts in Cape Colony for April last amounted to £4,889, against £5,999 for the same period of last year, or a decrease of £1,110.

THE AMERICAN BRUSH COMPANY.—It is stated that the 100-dollar shares of this company, which started two years in advance of the Anglo-American Brush Company, now stand at 7,000 dollars.

SOCIETY OF ARTS.—This Society has awarded a silver medal to Professor Silvanus Thompson, D.Sc., for his paper on the "Storage of Electricity," read during the Session 1881-82. This paper will be found in our last volume.

ELECTRIC LIGHT AND POWER GENERATOR COMPANY.—A meeting of this company is to be held on the 27th inst., when it will be proposed that the name should be changed to the "Maxim-Weston Electric Company (Limited)."

PERSONAL.—Mr. William Kingsland, A.S.T.E., &c., late superintending electrician to the Hammond Electric Light Company, has been appointed electrical engineer to the Yorkshire Brush Electric Light and Power Company.

CAIRO.—The Eastern Telegraph Company notified on the 15th instant the temporary closing of its office in Cairo. Telegrams for Cairo can only be accepted at the sender's risk, to be forwarded from Alexandria by best means.

TENDERS WANTED FOR ELECTRIC LIGHTING.—Tenders are being invited for lighting Honley Exhibition by means of electricity. For further particulars apply to the Secretary, Exhibition Committee, Honley National Schools, near Huddersfield.

ELECTRIC LIGHTING FOR TRAINS.—It is said that experiments are being made on the Alsace-Lorraine Railway with the view of lighting trains by electric light during their passage through tunnels, the motive power being supplied by the locomotive.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company, for the week ending the 9th inst., were £2,180 after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

THE TELEGRAPH ON THE CHINESE BORDER.—A Reuter's telegram from St. Petersburg, dated June 16, says:—"The Kuldja telegraph line will be removed, as it is being continually damaged by the Chinese. The Sinbun line is also frequently interrupted."

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The gross earnings of this company's traffics and steamer for the two months ending May 31st, 1882, amounted to £6,100, against £5,050 in the corresponding period of last year, showing an increase of £1,050.

EASTERN EXTENSION TELEGRAPH COMPANY.—This company notify that the coupon due July 1 proximo, on their Five per Cent. Australian Government Subsidy Debentures, will be paid on and after that date at the banking house of Messrs. Barclay, Bevan, and Co.

GLASGOW.—We understand that the Glasgow Post Office is to be lighted throughout by Messrs. Crompton and Co. The decision has been arrived at after a two years' careful trial of the electric light, during which time there has been a complete absence of breakdown.

ALEXANDRIA.—A telegram from the *Daily News* correspondent, dated Alexandria, Sunday, stated that the Eastern telegraph clerks had gone to live on board the company's ship "Chiltern," close to the office opened on the Peninsular and Oriental Company's premises at Gabbary.

CARDIFF.—The *Western Mail* office is now lighted throughout with Maxim incandescent lights. The lamps and dynamos have been installed by the Electric Light and Power Generator Co. The arrangements are very complete, and we hope to be able to illustrate the whole in an early number.

PROPOSED NEW CABLE.—Signor Baccarini, Minister of Public Works for Italy, recently laid a Bill before Parliament for approving a convention with the Eastern Telegraph Company for laying a cable between the Lipari Islands and the Island of Salina. The Chamber granted urgency to the Bill.

NEW TELEGRAPH COMPANY.—The Baltimore and Ohio Telegraph Company has been formed at Albany, New York. The general route of the lines is from New York to Brooklyn, thence across New York Bay to Edgewater, through Richmond County to or near Tottenville. The capital is 100,000 dollars.

PROTECTION OF CABLES.—At a meeting of the Executive Council of the Associated Chambers of Commerce on the 9th instant it was resolved that "The President be requested to make inquiries, and to press the Government to take steps for the preservation of telegraphic cables between this country and the continent."

CRYSTAL PALACE.—Major Flood Page has resigned the post of manager of the Crystal Palace, and accepted that of general manager of the Edison Indian and Colonial Electric Light Company. The Crystal Palace Company are advertising for a successor to Major Page at a salary of £750. Applications to be sent in before the 11th July.

THE FAURE ELECTRIC ACCUMULATOR COMPANY.—An extraordinary general meeting of this company will be held on the 29th inst. at the Cannon-street Hotel, at 12 noon, to receive a statement from the directors, and consider the future policy and business of the company under circumstances which will be explained to the meeting.

FRENCH TELEGRAPHS.—According to the report on the Post Office Estimates for 1883 the number of telegraph offices in France will next year be 6,448, against 4,561 in 1877. The total length of telegraph lines will have increased from 57,090 to 87,020 kilometres, whilst the increase in the number of telegrams will be 157½ per cent.

BERECHURCH HALL.—Mr. Coope, M.P. for Middlesex, has decided to light his new mansion throughout by the electric light. The Swan incandescent lamp is to be used, and the work, as in the case of the Glasgow Post Office, will be carried out, in consequence of the new arrangements with Messrs. Crompton, by the Swan United Company.

THE TELEPHONE AND THE MASSACRE IN EGYPT.—The Alexandria correspondent of the *Standard* says, in the issue of that paper for Saturday last:—"It was fortunate that telephonic communication was established between Sir B.

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Seymour and the British Consulate before the riot of Sunday broke out. To this is attributed the saving of many lives that would otherwise have been sacrificed."

ELECTRIC LIGHT IN SALFORD.—Mr. M. Ruddle, engineer to the Edison company in Manchester, writes with reference to the note in our issue of June 10 on the Edison plant used by Messrs. Mather and Platt, of Salford, as follows:—"Will you kindly note for correction that the power is supplied by one quick-speed engine of 6 horse-power nominal for 138 lamps and a 2 horse-power motor, which drives several lathes. I may add that in point of steadiness the engine, which is manufactured by this firm, leaves nothing to be desired."

TELEGRAPHIC ERRORS.—The *Daily News* is responsible for the following:—"The Stock Exchange rumours of resignations in the Ministry were the subject of amused comment in the House of Commons last night (Monday, June 19). Amongst other stories current on the subject is one to the effect that, by an error in the transmission of a telegram, the message 'Bright and Chamberlain resigned' was delivered to a large operator in railway shares as 'Brighton chairman resigned,' and that he promptly proceeded to sell Brighton stock."

ROYAL SOCIETY OF EDINBURGH.—At the fourteenth ordinary meeting of this society on Monday last, Lord Moncrieff, the president, presented the Keith prize for the biennial period 1879-81 to Professor Chrystal for his paper "On the Differential Telephone." After the reading of several other papers, Dr. A. Macfarlane stated the outcome of experiments described in a paper by himself and Mr. D. Rintoul, M.A., on the "Effect of Moisture on the Electric Discharge," to be such as to justify the conclusion that the drying of air increases the resistance to the disruptive discharge. The paper referred to was given in our last volume.

THE BOTANICAL GARDENS.—On Thursday night at the annual *fête* the conservatories and the principle tent were ighted by means of Maxim incandescent and Weston arc lamps. The arrangements were carried out by the Electric Light and Power Generator Company. Three Maxim machines, driven by a Ransome's portable engine, generated the current for about 250 Maxim lamps, and one Weston machine was used to obtain the current for ten Weston arc lamps. The President of the Society, the Duke of Teck, interested himself greatly in the lighting, and suggested some of the arrangements, which were admirably carried out.

ELECTRIC LIGHT AT THE CRYSTAL PALACE.—The Crystal Palace authorities have decided to continue the lighting of the terrace throughout the coming summer months by the André system of electric lighting, and have sanctioned the extension of the system to the track and station of the new electric railway which is about to be opened in the grounds. The terrace is now lighted by 12 arc lights of the kind designed by Mr. André for street lighting, and the railway track will be illuminated by four arc lamps of another type, intended for general lighting purposes. The railway station will be lighted by 30 André incandescent lamps. This new railway will be opened in a few days.

CENTRAL AND SOUTH AMERICAN CABLE.—The India Rubber, Gutta Percha, and Telegraph Works Company have received a telegram from Mr. R. K. Gray, engineer-in-chief, dated Panama, 13th instant, stating that the "Silvertown" and "Retriever" were then coaling at Panama. Mr. Gray expected that the Buenaventura-Panama section of the cable would be completed by the 20th instant. Another telegram received by the company from their ss. "International," says that the cable she had on board for the Mexican cables extension has been successfully laid, and that she intended going to Brazos to splice the Tampico-Brazos section to the cable now laid to Galveston.

ELECTRIC LIGHT AT STAFFORD HOUSE.—On Friday last the Duke of Sutherland invited a number of gentlemen interested in electric lighting to see the incandescent system as it has been applied to his town residence, Stafford House, by the British Electric Light Company. The total number of lamps in use is 258, of 20 candle-power each. The picture gallery, which is 123ft. in length, is lighted by 176 lamps, and the banqueting room, 62ft. long, by 73 lamps. The machinery has been temporarily erected in the garden. There are six Gramme dynamo machines. The whole of the work has been carried out in five weeks. The lighting was continued on Friday night for about two hours, and gave great satisfaction to those present. The company are to be congratulated on the way in which the installation has been effected by their engineers.

TELEPHONE LICENSES.—In the House of Commons on Thursday week, The O'Donoghue asked the Postmaster-General whether, taking into account that nearly a month had elapsed since he informed the House that he was considering the application of the London and Globe Telephone and Maintenance Company for a license, he could now state the decision at which he had arrived; and, if not, within what period he expected to be able to announce his decision.—Mr. Fawcett replied that the question as to the granting of telephone exchange licenses involved many important and difficult issues. The subject had been for some time engaging his careful attention, and, although he regretted that he could not fix the precise time when he would be able to announce a decision, he assured the hon. member that there should be no unnecessary delay.

ELECTRIC EXHIBITION AT MUNICH.—It is stated that the Bavarian Postal Telegraph and Railway Department have placed at the disposal of the committee of the above exhibition a train for experimenting with the electric light as an illuminant for the carriages, and also as a headlight for the locomotive. Long lines for telephonic experiments have likewise been placed at their disposal by the same department; the longest of these lines is said to be that between Munich and Dresden, a distance of 550 kilometres. It is expected that at least 3,000 horse-power will be obtained from the river Isar, and transmitted by means of electricity to various places, there to be reproduced in the shape of light and power. A special committee has been appointed to report on the electric light systems shown, and if deemed advisable, to adopt one as a means of illuminating the streets of the town.

SIXPENNY TELEGRAMS.—In the House of Commons on Thursday week, Mr. Stanhope asked the Postmaster-General whether he would lay upon the table the correspondence which had passed between him and the Committee of Lloyd's with reference to a proposal to adopt a sixpenny rate for certain telegrams, and an undertaking on the part of the Committee to indemnify the Government against any loss that might accrue from the experiment. In reply, Mr. Fawcett said:—"It is not usual to lay on the table such correspondence as that to which the hon. member refers, and I regret, therefore, that I am not able to comply with his request. I may, perhaps, add that in declining the proposal to which reference is made I was mainly influenced by the opinion that whenever sixpenny telegrams are introduced they should not be confined to any particular company or association, but that the public generally should participate in the change."

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International Telegraph Statistics.—According to statistics recently issued by the International Bureau of Telegraphic Statistics at Berne the total length of telegraph lines at the present time is:—Russia, 50,090 miles; Germany, 44,265 miles; France, 43,650 miles; Austria-Hungary, 31,015 miles; Great Britain, 26,465 miles; Italy, 16,430 miles; Sweden and Norway, 12,625 miles; Switzerland, 4,097 miles; and Belgium, 3,505. The length of wires in the various countries is as follows:—Germany, 159,910 miles; Russia, 134,465 miles; France, 125,265 miles; Great Britain, 121,720 miles; Austria-Hungary 89,960 miles; Italy, 53,692 miles; Sweden and Norway 28,445 miles; Belgium, 16,345 miles and Switzerland, 10,010 miles. The total number of messages sent during the past year are classed as follows:—England, 29,820,445; France, 19,882,628; Germany, 16,312,457; Austria-Hungary, 8,729,321; Russia, 7,298,422; Italy, 6,511,497; Holland, 3,109,230; and Sweden and Norway, 2,028,805.

Electric Light in India.—We take the following from the *Homeward Mail* of recent date:—"A correspondent, writing from Indore on May 26, says:—'The Queen's birthday was celebrated with due ceremony by the usual parades of troops at Indore and Mhow. . . . In the evening a banquet was given by Appia Bolia Sahib, son-in-law of Maharajah Holkar, in the Residency Grounds, to the Agent, Governor-General, and all the political and military officers of Mhow and Indore. The lawns and gardens on the banks of the river were superbly lighted with electric lamps furnished from Bombay by the Eastern Electric Light and Power Company. The distinguished firm of Kibbio Boos, a family whose name is intimately associated with Central Indian history, gave last year, on the Queen's birthday, a similar entertainment, which was considered a brilliant success; while the *fête* of the present year has been remarkable for introducing for the first time and on a large scale the electric light into Central India.'"

Accumulators and Tramways.—In an article dealing with the various powers used on tramways—viz., horse, steam, and electric, our excellent contemporary, the *Builder*, points out that the reason steam has not succeeded as a motive power for tramways is its excessive cost. According to our contemporary's figures it costs "16d. to do on a tramway what it costs 2d. to do on a railway, and two-thirds of a 1d. to do on a canal." The article concludes as follows:—"It is in the direction of the use of electric power by accumulating batteries that we think the best prospect of mechanical tramway working at present offers itself. It is well known to be the fact that it is the strain of starting the cars that most tries the horses, and that, in fact, makes the horse-power so costly. We ventured to anticipate that the most successful mode of tramway working which at the present time is attainable is the use of horse traction, supplemented by a starting force to be supplied by an accumulator, which might also receive the force otherwise wasted in stopping."

The Electric Lighting Bill.—It is stated that an effort will be made to prevent the passing of the Bill this Session, and that pending the selection of some more important leader, Mr. Warton has undertaken to block the Bill. In the House of Commons, on Monday, Colonel Makins gave notice that he should move that it was undesirable to retain in the Bill the novel powers proposed to be given to the Board of Trade to grant licenses to local authorities, companies, or persons enabling them to exercise powers which had hitherto only been granted by Act of Parliament, or by provisional orders confirmed by Act of Parliament, and that the Bill be referred back to the committee with instructions to strike out all provisions authorising the granting of such licenses by the Board of Trade. Mr. Kynaston Cross has also proposed an amendment to the Bill, the object of which is to obtain payment for the undertakers, in the event of purchase by a local authority, either wholly or in part, for the goodwill, to an amount not exceeding 25 per cent. on the structural value of the concern.

New Companies.—The Markland Electric Lighting Power and Regulator Company has been formed, with a capital of £200,000, to work the Markland arc lamp and regulator in England. The lamp is an American invention. Mr. J. A. Barrett has been appointed consulting electrician, and Mr. J. A. Graham electric engineer, to the Company. The offices are at 8, Tokenhouse-yard, E.C.—The Anglo-Spanish Brush Electric Light and Power Company has a capital of £200,000, and will work the Brush and Lane-Fox patents in Spain and its colonies.—The Telephone Company of Ireland has a capital of £200,000, and has obtained a license from the United Telephone Company to use their telephones and apparatus in Ireland (excluding the Province of Ulster). The company has also acquired the existing business of the United Telephone Company in Dublin. Professor W. Barrett, F.R.S., is consulting electrician.—The Electric Lighting Supply and Fitting Company has a capital of £20,000, and has been formed to work Mr. Killingworth Hedges's patents. Its offices are at Victoria-mansions, Westminster, S.W.—The United Kingdom Economic Electric Light and Power Company has a capital of £500,000. It has been registered by Messrs. Cridge and Bell, 26, Bishopsgate-street Within, E.C.

The Telegraph Conference at Barbadoes.—The *Colonies and India* says:—"A conference of delegates, representing all the British colonies in the West Indies except Jamaica and the Bahamas, summoned by direction of Lord Kimberley to consider the best means of improving telegraphic communication between this country and our possessions in that part of the world, has been sitting at Barbadoes for some time past. After carefully examining into the various interests involved the delegates have recommended the adoption of a scheme which has been more than once urged in these columns during the last six or eight years, viz., the establishment of a line of cable connecting all the British West Indian Islands with Halifax, Nova Scotia, *vià* Bermuda, thus affording a means of communication exclusively through British territory. The cost of such a cable is estimated at a million sterling, and it is proposed that the expense should be borne in equitable proportions by the Home Government and the various colonial Governments. The advantages of such a scheme are self-evident. Bermuda and Halifax, the principal naval stations in the Atlantic—the one stationed, sentinel-like, far out towards the middle of the ocean, the other on the mainland—would be placed in close connection with each other, and would link our important West Indian possessions directly with the rest of the Empire. The value of Bermuda, from a strategical point of view, would be vastly increased; while it would also be able to serve the hardly less valuable purpose of a meteorological station, giving timely warning of the approach of storms across the Atlantic. At present we are dependent for West Indian news on intelligence transmitted through the United States. In the event of war such a state of things would be intolerable."

The Telegraph in Egypt.—The following letters appeared in *The Times* of June 19 and 20 respectively. The first is signed "E. A. Floyer, Inspector-General of the Egyptian Telegraphs," and is dated from the Royal Geographical Society. It reads as follows:—"Sir: This morning a gen-

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tleman told me that on offering a telegram to Cairo it was refused, and he was told that it could not be sent further than Alexandria. He happened to know Egypt well, and insisted on his telegram being despatched. But the refusal may be made to other people less able to expose its absurdity, and it is to prevent such error that I beg you to insert this letter. The condition of the Eastern Telegraph Company's wires between Cairo and Alexandria is of the smallest moment to telegraph communication between those places, which is still less affected by the 'removal of the European telegraph office from Cairo,' announced in the papers as if of some significance. The lines of his Highness the Khedive, maintained by Egyptian engineers and worked by European and Egyptian clerks, are amply sufficient for any number of messages they are likely to get, and can, as before, lend the Eastern Company a wire if theirs are broken down." To this Sir James Anderson, managing director of the Eastern Telegraph Company, replied:—"In reference to Mr. Floyer's letter in *The Times* of this date (June 19) I beg to say that no messages for Cairo have been refused at the offices of this company, and if the Post Office have done so we have no information of it. It was only after the most urgent warning to our people at Cairo that 'the time for illusions was past, and that their safety was imperilled,' that the office was temporarily closed, the staff professing their eagerness to remain until the last moment. The directors did not think it their duty to imperil men's lives when the traffic could equally well be transmitted with comparative safety. The communication is as rapid as ever it was, with the single exception of runners being employed between the temporary station in the harbour and the office in the city of Alexandria."

THE ELECTRIC LIGHT FOR THE CITY.—At a meeting of the Commissioners of Sewers on Tuesday, a motion, "That it be referred to the Streets Committee to consider whether steps should not be taken to provide that all arrangements in regard to electric lighting within the City, whether of public ways or private premises, necessitating interference with the pavements, be undertaken by the Commission," was agreed to. It was likewise referred to the same committee to consider a memorial of merchants and traders, asking that any systems of electric lighting adopted by the Commissioners might be utilised for the convenience and benefit of private houses. The memorial stated that the subscribers to it, who were large contributors to the rates, had viewed with approval the action of the Commission in experimentalising in street lighting with the electric light, and pointed out that they were now very largely under the power of the gas companies, and that it would be much to their benefit if they had the choice of using either gas or the electric light. Many of the memorialists would be willing to enter into contracts with the electric companies to supply them with the light from cables laid in the street; but they found that electric engines on their own premises were the only means by which they could obtain the electric light. They, therefore, prayed that the Court would grant to such of the electric lighting companies as it might think fit the right of lighting private houses, shops, and warehouses, any contracts entered into being for a period of not less than three years. The chief points urged by the deputation which presented the memorial were that the permanent way or pipes should be laid down by the Commissionrs of Sewers, and every facility given to the petitioners and others to be supplied from the mains with the electric light. The Streets Committee, reporting on their proceedings relative to the applications made for an extension of the experiments in electric lighting, submitted an abstract of tenders received, and expressed an opinion that it was not desirable to proceed further until Parliament had decided the principle upon which electric lighting generally shall be permitted. It appeared from the tenders included in the report that the estimated cost of applying the electric light to the four districts into which the principal City streets had been mapped out varied from £9,500 to £17,000. In one instance the lowest contract in one district was £2,190, and the highest £5,700. The gas consumed in the whole of these districts was only £1,860 per annum.

THE RIOT AT ALEXANDRIA.—The following account of the late riot at Alexandria, written by a member of the Eastern Telegraph Company's staff at Alexandria, has appeared in the daily press:—"I had better give you my personal experience of what occurred. At three p.m., five of our fellows went out boating in the harbour. Having been on night duty, I was asleep until a quarter to four, when I went out with two others to see some friends. As we arrived we heard a shot fired, followed soon after by two more. We took no notice, but went upstairs, where we found them all loading rifles and guns, in case of a rising, which, they said, had been threatening for some time. There were two ladies (to whom the house belonged) and the captain of one of the ships in the harbour. So it was proposed to send the women on board, in case of accidents. They were sent off with the captain and another man. Whether they got on board safe or not I don't know, but God help the poor girls if they got into the hands of those brutes of Arabs. We then went back to quarters and got our revolvers. There were four of us, and we determined to go to the harbour and warn the other men not to come up, or else to come immediately, before the row commenced. We drove all right until we got to the turning down to the landing-stage, when all of a sudden a crowd of Arabs rushed round the corner, shouting 'Down with the Unbelievers!' 'Death to the English!' Before we knew where we were we got beaten about the head with sticks. We all got out of the carriage, revolvers in hand. As I was alighting an Arab caught me a fearful blow on the top of the head with a stick. I marked him, aimed carefully, when I found that my revolver had got jammed somehow, and would not fire. I cocked it and levelled again, but the thing would not go off. Almost at this moment I received a tremendous blow on the top of my scull, and another on my wrist, which knocked my pistol out of my hand. I stooped to pick it up, when I received a stroke on the back of the head, which I shall not soon forget. It struck me that I should be no good to the other fellows if I stayed, so turned and fled for a good half mile. I ran the gauntlet up the street streaming with blood, either dodging or else going straight at the Arabs and striking with my fists somehow or other. I was covered with blood, and was just sinking when I espied a chemist's shop open, rushed in, and sank on a chair. As it happened, I arrived at the right moment and in the right place, for there were sixteen young medical students, well armed to the teeth, one of whom dressed my wounds and gave me some lemonade, and made me lie down on a divan, with orders not to say a word, assuring me that I was quite safe. I sent a note to our quarters, and at nine in the evening they sent four men, well armed, to fetch me. One of my other comrades turned up; the remaining two have not been heard of. A party has been sent to the hospitals and Consulates to search for them, and, dead or alive, to find them. There is still hope they may have taken refuge somewhere and may turn up. I lost my revolver, watch chain, one shoe, my hat, and stick."

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THE PHENOMENA OF THE ELECTRIC DISCHARGE WITH 14,400 CHLORIDE OF SILVER CELLS.*

BY WARREN DE LA RUE, ESQ., F.R.S., SEC.R.I., ETC.

(CONCLUDED FROM PAGE 103.)

The effects described were produced with 8,000 cells, but with 11,000 cells we obtained a further confirmation of them, the effects being shown in another figure on the diagram (Fig. 17), which represents a streamer discharge between two points. The negative discharge is a brush which is seen continuously on the lower terminal, while the positive consists of a series of intermittent, ever-changing spiral streamers which envelop the negative brush discharge without in the least disturbing its form. They go past the negative point and then curl up towards it.

If I insert a very high resistance between the battery and the terminals the streamer discharge ceases, and a static spark

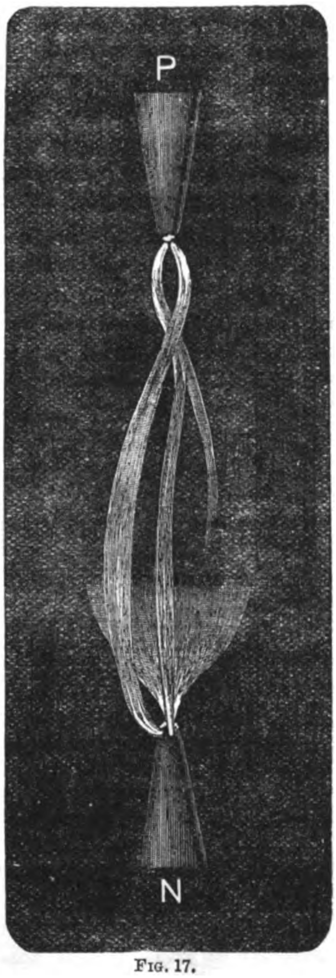

Fig. 17.

passes from time to time which is exactly like that from an ordinary frictional machine; it pierces a thin strip of paper just as a static charge would do. The battery gathers up at intervals a charge at the terminals, and the discharge occurs as soon as the potential is sufficient to force its way across the obstacle opposed by the intervening air.

The same thing occurs if I attach a condenser to the terminals of the battery; it takes a longer time for the battery to charge it, and consequently the discharge occurs at longer intervals, shorter or longer according as the terminals are adjusted to a less or greater distance. The condenser I am now using has a capacity of 1·5 microfarad, and hence the accumulated charge is very considerable, and the discharge is like that of a powerful electric battery. But whether the capacity of the accumulator be large or by comparison infinitesimally small like that of the points in the discharging micrometer, there is always an interval of time which elapses between successive discharges; the interval may be so extremely minute that thousands of millions of discharges may occur in a second, but the flow is discontinuous, like the stream of water before referred to.

I will endeavour to prove to you that an apparently perfectly steady discharge through a vacuum tube, in which there is no apparent motion of the strata, and in which even the rotating mirror would fail to detect any intermittence, is nevertheless discontinuous. It is true that the period of pulsation must be of a very high order, millions in a second, and it is necessary, therefore, to have recourse to special means in order to detect it, which I will describe.

The current from the battery of 2,400 cells is made to pass through the primary of an induction coil, and then through a vacuum tube (No. 142, Fig. 11 in the plate*) containing a residue of carbonic acid at a pressure of 0·4 millimetre. The arrangement is shown in Fig. 18, where T T′ is the vacuum tube connected in circuit with the primary of coil 819; Z A the battery, on the A side connected with fluid resistances F R, F R′, and wire resistances amounting in all to

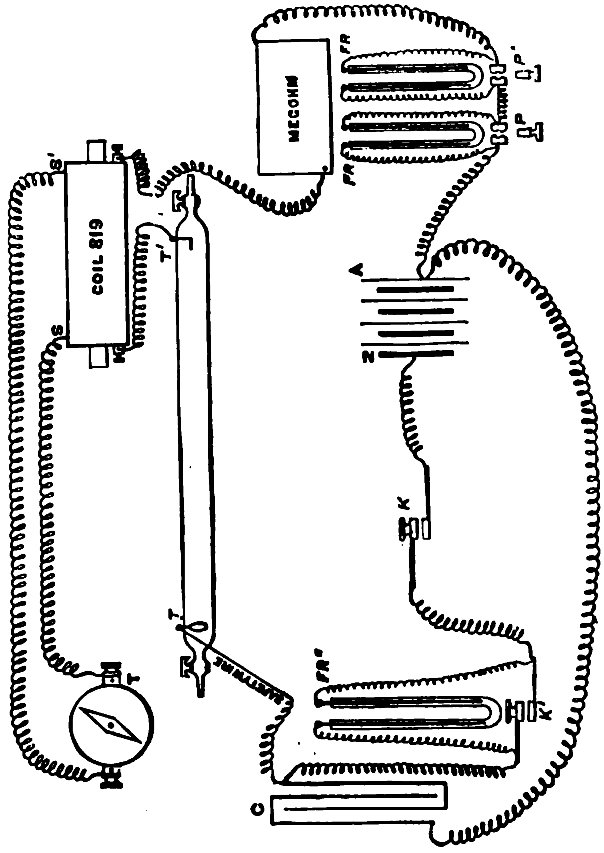

Fig. 18.

a megohm. On the Z side is shown a condenser C, connected through a fluid resistance F R″ with the Z pole. The terminals of the secondary wire of the induction coil are connected with a sensitive Thomson galvanometer. If there is any intermittence in the current through the tube, an effect will be produced on the galvanometer *under certain circumstances*, that is, provided the rise and fall of the current occur in unequal periods. I will now make connection with the battery. You perceive that there is a deflection of the galvanometer to the left on making contact; I will now allow the spot of light to come to rest, and then break contact, and there is a deflection in the reverse direction, that is, to the right. The first is called the inverse current, the last the direct current. I will now send the current again through the primary of the induction coil and thence through the tube, but in the first instance I will short-circuit the secondary current so that the galvanometer may not be disturbed when the connection with the battery is made. Now that the strata

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* The Plate referred to here and in several places further on appear only in the original *Proceedings*.

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are perfectly steady, I will allow the induced current to go through the galvanometer by removing the short-circuit plug, and you see that there is a slight *permanent* deflection of the galvanometer. This shows that the discharge in the vacuum tube, although apparently quite steady, is a pulsating one; as the swing is to the right we know that the current is a direct or break contact one, thus indicating that the discharge through the tube increases comparatively slowly, then drops more suddenly. If the rise and fall were in equal times, there would be no deflection of the galvanometer.

If the terminals of a telephone are placed in the circuit between the battery and a vacuum tube, the pulsations are sometimes sufficiently slow to produce audible sounds when the telephone is placed to the ear. But the telephone is not adapted to render evident intermittences of a very high order.

There is a remarkable phenomenon which occurs when a charge is sent through a closed vessel containing air or gas,

The discharge, in the bell jar, was photographed on one occasion, and the central spindle or arc proper was measured on the photograph, and a calculation made of what its temperature must have been on the supposition that the sudden dilatation might be due to it, and the result was 16000° Cent. Experiments were also made to ascertain the temperature of different parts of the arc, and it was found that platinum wire 1-1000th of an inch in diameter was immediately fused, but there was no vaporisation of the platinum, which certainly would have occurred had such a temperature as 16000° Cent. existed. It was ultimately concluded, from a number of experiments and considerations, that the enormous and sudden dilatation could not be attributed to a sudden increase of temperature, but must be caused by the scattering of gas molecules away from the terminals, and their projection by electrification against the walls of the containing vessel.

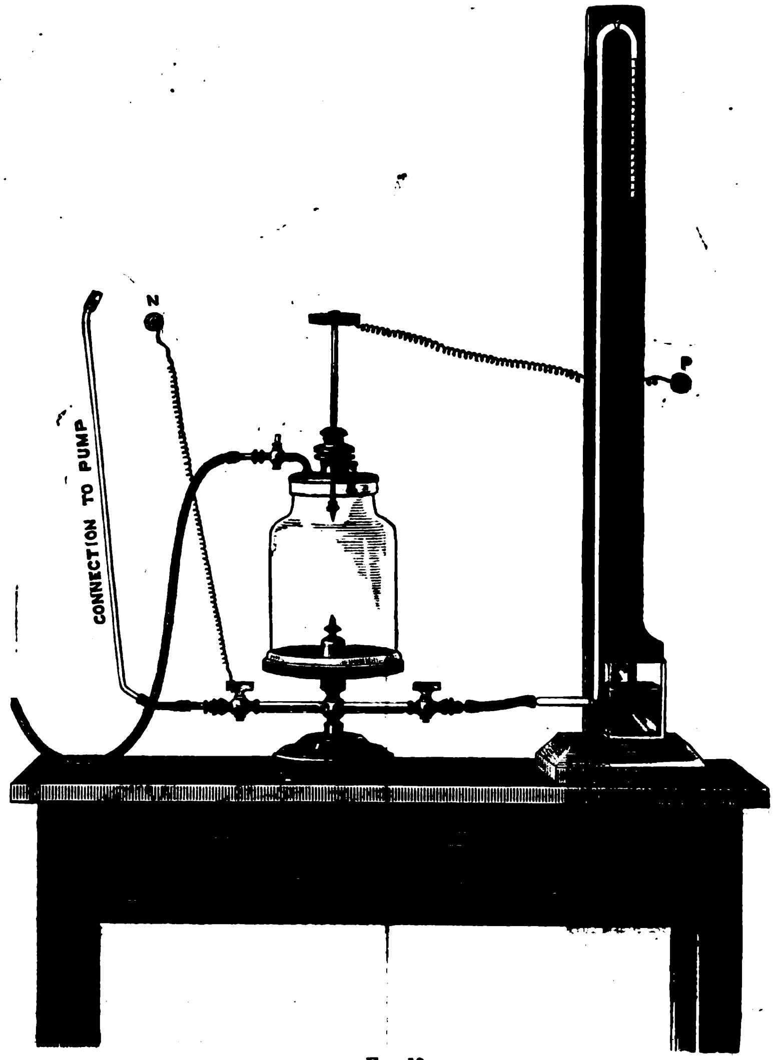

FIG. 19.

within certain limits of pressure, which I will endeavour to show you. As soon as the connection is made between the battery and the terminals a sudden expansion of gas takes place, as you will see (Fig. 19) by the depression of the mercury in the gauge connected with the bell jar, and as soon as the connection with the battery is broken the gas returns suddenly almost exactly to its original volume, showing only a small increase due to a slight elevation of temperature; the mercury in the gauge rises, therefore, nearly to its original position. The effect is similar to that which would be produced if an empty bladder suspended between the terminals had been suddenly inflated and as suddenly emptied. The ratio of the increased volume (pressure) to the normal volume in our experiments rose sometimes as 1·71to 1, and in others there was scarcely any appreciable increase; in the present instance it is as 1·4 to 1.

We have proved experimentally that the discharge in a vacuum tube does not differ essentially from that in air and other gases at ordinary atmospheric pressures; it cannot be considered as a current in the ordinary acceptation of the term, nor as at all analogous to conduction through metals, and must consequently be of the nature of a disruptive discharge, the particles acting as carriers of electrification. For example, a wire having a given difference of potential between its ends can permit one, and only one current to pass; whereas we have found by accurate measurements that with a given difference of potential between the terminals of a vacuum tube, currents of strength varying from 1 to 135 can flow.

We have found, moreover, that the resistance of a vacuum tube, unlike that of a wire, does not increase in the ratio of the distance between the terminals. As an example may be

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cited that, in a Spottiswoode tube (Fig. 20) with one shifting terminal, which can be placed at any required distance from the other, for seven times the distance between the terminals the resistance was found to be only twice as great. Moreover the fall of potential is not uniform for equal increments of distance between the terminals of a vacuum tube as it is for equal increments of the length of wire. In order to determine this we used a tube with seventeen rings inserted in it at equal distances (Fig. 20); to these were attached wires which projected through the tube, and were soldered to it. One pole of the battery was connected to No. 1 ring

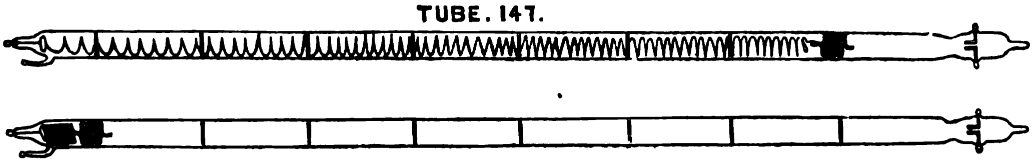

Fig. 20.

of the tube, and the last ring as well as the second pole of the battery were connected to earth and stood at zero. By means of an electrometer, shown in Fig. 21, the induction plate of which could be made to communicate with each

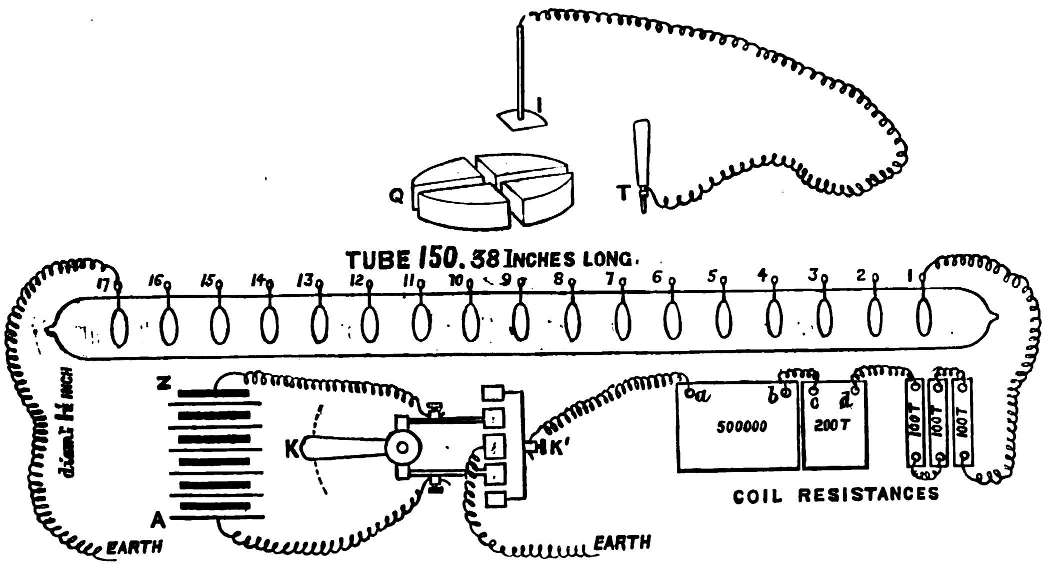

Fig. 21.

ring successively, it was found that the difference of potential between the first pair of rings, reckoning from the terminal connected with the battery, was five times as great as that between the eighth and ninth; again, that between

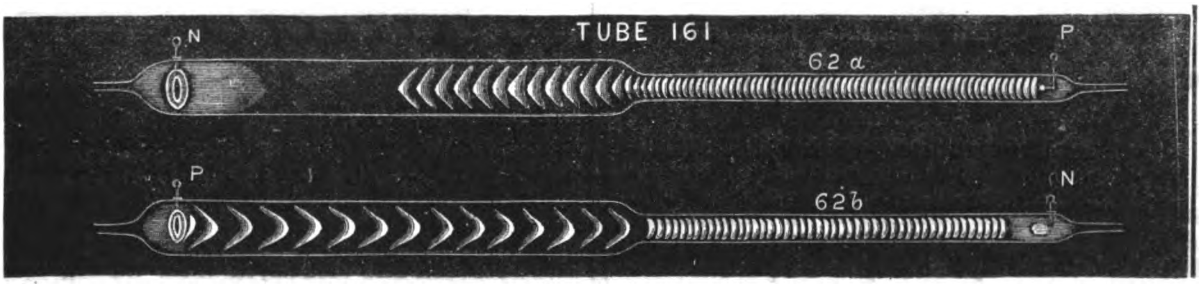

Fig. 23.

the sixteenth and seventeenth it was twice that between the eighth and ninth. If I, by way of illustration, suspend a number of pith balls to a wetted thread, one end of which I connect with one pole of the battery and the other to earth, the other pole of the battery being also connected to earth, you will notice a uniform decrease of divergence of the balls, because the potential decreases uniformly for equal distances, whereas this does not occur when pith balls are suspended to the rings of a vacuum tube, as you will see when I connect the first ring to one pole of the battery and the other to earth.

We will now take up the phenomena exhibited by vacuum tubes. It will be seen that the strata have their origin at the positive pole. Thus, in a given tube, with a certain gas, there is produced at a certain pressure, in the first instance, only one luminosity, which forms at the positive terminal; then, as the exhaustion is gradually carried further, it detaches itself, moving toward the negative, and being followed by other luminosities, which gradually increase in number up to a certain point. This I will show you, with Mr. Cottrell's aid, by projecting copies of photographs, made in my laboratory, from tubes containing hydrogen at gradually decreasing pressures.

If I now connect the fixed terminal of the Spottiswoode tube, containing residual carbonic acid at a pressure of 1 millimetre, with the positive pole of a battery of 2,400 cells, having first caused the movable terminal (which I have connected previously to the negative pole) to approach quite close to the positive wire, you will see only one stratum. I incline the tube and allow the negative terminal to recede. Now there are three strata (Fig. 10 in the plate), and as the negative recedes further and further fresh strata pour in one by one from the positive until the whole tube is filled to within a constant distance from the negative with our electric drops (Fig. 9 in the plate).

I may here pause to draw attention to the resemblance of the strata produced by an electrical discharge in a vacuum tube to the lycopodium records of sound-pulsations in air in Tyndall's work on "Sound" (Fig. 22, next page).

With the same potential the phenomena vary with the amount of current which is allowed to pass through the tube, and this amount we can easily regulate by inserting resist-

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ances between the battery and the tube. As the current is increased the number of strata in some tubes increases, but with other tubes the number decreases.

A change in the amount of current frequently produces an entire change in the colour of the strata. For example, in a hydrogen tube from a cobalt blue to a pink (Figs. 4 and 3 in the plate). It also changes the spectra of the strata. Moreover, the spectra of the illuminated terminals and those of the strata differ; usually the most brilliant spectra are obtained from the negative terminal.

If the discharge is irregular and the strata indistinct, an alteration of the amount of current makes the strata distinct and steady; most frequently a point of steadiness is produced by the careful introduction of external resistance; subsequently, with the introduction of more resistance, a new phase of unsteadiness, and still more resistance, another phase of steady and distinct stratification.

At the same pressure, and with the same current, the diameter of the tube affects the character of the stratification (Fig. 23, preceding page), as will be seen when I cause the current to pass in tube No. 161, which contains residual hydrogen. It consists of two portions, one 18 inches long

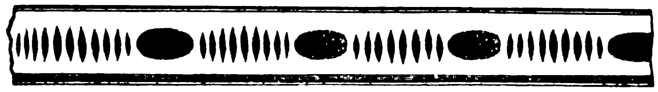

Fig. 22.

and 1·15 internal diameter, the other 17·5 inches long and 0·975 inch diameter. The battery I am using consists of 4,800 cells, and you perceive that whether the terminal in the small tube is positive or negative there is a marked difference in the form and closeness of the strata in the two tubes.

The greatest heat is developed in the vicinity of the strata. This fact we established most easily when the tube contained only one stratum, or a small number separated by a broad interval. There is reason to believe that even in the dark discharge like that in the neighbourhood of the negative terminal there may be a kind of stratified formation, for we have found a development of heat in part of a tube in which there was no illumination except on the terminals.

There are vacuum tubes made which are not open from end to end, and which consist of a number of separate chambers, some inserted into the others. The induction coil illuminates these very beautifully, but the battery will not do so, as no discharge can take place through them. On the other hand, the alternating currents of an induction coil charge up such a tube first with positive, then with negative,

TUBE 123.

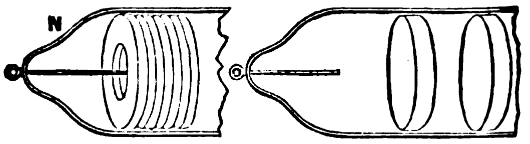

Fig. 24.

electricity, and produce an illumination in consequence of the alternating charge and discharge of the walls of it. When I turn on the battery current you will perceive a flash, then if I reverse the current another flash, and if I do this quickly I make the illumination a little more persistent. But I have a rapidly reversed commutator by which I can reverse the current 350 times in a second, and you see that with its help I can illuminate the tube very beautifully.

In almost every case there is a dark interval near the negative terminal, but occasionally we have met with tubes in which the strata completely fill the tube, the last ones threading themselves on the wire used for the negative terminal (Fig. 24). Unfortunately I have not one which I can show you, as these tubes which have shown this phase completely change after the current had passed a very short time.

I now propose to show, with the aid of my two assistants, Messrs. James Fram and Ernest Davis, some tubes with various gases at different degrees of exhaust, in order that you may see the strata in all their beauty and witness the changes of which I have spoken.

I will in the first place show a tube in which there are produced a series of luminosities like those in one of the photographs which were projected on the screen. It is No. 148, with residual hydrogen at a pressure of 4 millimetres, and connected with 7,920 cells. Fig. 8 in the plate shows the phenomenon; it is from a photograph obtained in four seconds.

Tube 201, shown by Fig. 7 in the plate, is a hydrogen vacuum at a pressure 0·8 millimetre; with 3,600 cells and an interposed resistance of 1,500,000 ohms, a perfectly steady close stratification is produced. The figure is copied from a photograph obtained in three seconds.

Tube 139, shown in the plate by Fig. 4, is a hydrogen vacuum, pressure 0·8 millimetre, with 3,600 cells and an interposed resistance of 200,000 ohms. A series of beautiful blue double strata are produced, with a carmine line between the double strata. The figure is copied from a photograph obtained in one and a half second.

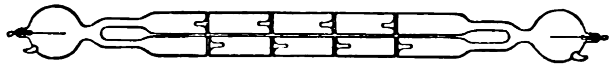

Fig. 25.

Tube 139.—On interposing 500,000 ohms resistance in the circuit, instead of 200,000, the strata are reduced in number and turn pink. The phenomenon, except as regards colour, is shown in the plate (Fig. 6), copied from a photograph obtained in three seconds.

Tube 130, a hydrogen vacuum 0·8 millimetre, with 2,400 cells and an interposed resistance of 60,000 ohms. A series of tongue-shaped strata are produced, which cross each other like the components of the letter X, and remain perfectly steady. The phenomenon is precisely like that shown by another tube, the photograph of which you saw projected on the screen. Tube 130 is represented in the plate (Fig. 6); it is copied from a photograph obtained in two and a half seconds.

Tube 333 is a hydrogen vacuum, pressure 0·8 millimetre, with 3,600 cells and an interposed resistance of 1,500,000 ohms. There are produced a series of double-tongued shaped strata, united at their narrowest parts. This phenomenon is represented in Fig. 5 in the plate, which is copied from a photograph obtained in three seconds.

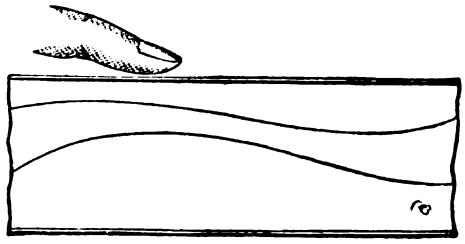

Fig. 26.

Before showing the next tube, I will exhibit one (No. 51) with a carbonic acid vacuum, in which the negative terminal consists of a wire 19in. long formed into a helix, the positive being a ring. On passing the current from a battery of 1,200 cells through the tube, first interposing a resistance of 500,000 ohms, about two inches only of the negative is illuminated; on gradually, however, removing the resistance, more and more of the spiral negative glows, until at last the whole of it is brilliantly illuminated. It will be seen by this that the negative discharge requires a greater outlet than the positive.

I will now exhibit a tube (No. 163), Fig. 25, consisting of two branches united at the top and bottom. In each of these is a series of funnels, the broad end of which fills the branch; in one branch the mouths of the funnels are placed in a con-

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trary direction to that in the other. On connecting the terminals with the battery of 3,600 cells, the current is free to pass either in both branches, or through one or the other, but it invariably passes down that branch in which the wide mouth of the funnel is towards the negative. It traverses alternately the right or left hand branch, according as I make the top or bottom terminal negative; thus again exemplifying the necessity for a greater space for the negative discharge to pass than is required for the positive. The phenomenon is shown in Figs 11 and 12 in the plate.

The photographs from which the figures in the plate are copied were taken in my laboratory by Mr. H. Reynolds, on dry plates.

Very frequently, when the exhaust is very great, the discharge becomes most sensitive to the approach of the finger or any conductor in connection with the earth, or charged by a separate source of electricity; the same thing occurs if the current is made intermittent by an interval of air in one of the connections (an air spark). See Fig. 26.

The preparations which were necessary in order that this lecture could be given have occupied a considerable time. In the first place, most of the tubes I have shown you had to be specially prepared, during the last three months, and reserved for this occasion. For all tubes completely alter their character if a current is repeatedly passed through them, and then they no longer present the beautiful phases of stratification you have witnessed. Moreover, it was not possible to remove the battery from my laboratory, as its contruction would not permit it. I therefore have had built up by Messrs. Tisley and Co. an entirely new series, in such a way that the battery can be carried away, when requisite, without injury. The construction of the battery was commenced in June, 1879, and was finished in August, 1880. The charging of the battery occupied a fortnight, and was finished in the second week in December.

It only remains for me to thank you for your flattering attendance under such adverse meteorological conditions.

HEDGES' PATENT SHUT OFFS AND SWITCHES.

These switches, which were first introduced by Mr. Killingworth Hedges at the Paris Electrical Exhibition, have

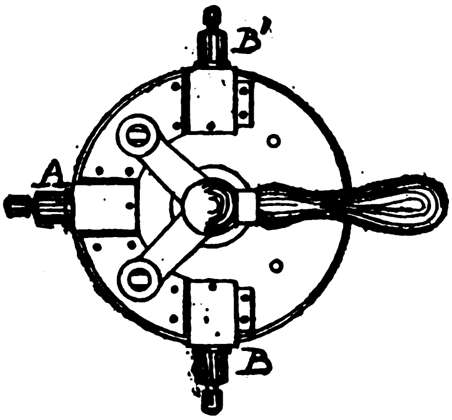

Fig. 1.

been steadily increasing in favour ever since. About eight varieties are now made to suit the strength of the current, and the number of directions into which it is necessary to shunt the current. The tendency to spark, and consequent destruction which takes place at the moment of breaking contact, is considerably obviated in Mr. Hedges' plan of causing the contact piece to slide on to a block of highly insulating and non-inflammable material, such as vulcanised fibre. With switches designed for powerful currents, the spark itself is considerably reduced by splitting the current into two or more portions. Fig. 1 shows the duplex switch of two directions on this principle for currents up to 50 amperes; the current enters at A and leaves either at B or B', according to the direction required. Fig. 2 is a switch employed with secondary batteries, for the purpose of either increasing the number of incandescent lights or the power of any set of lights. The current is increased by turning the handle to slide on to the set of contacts which are severally connected up to an increased number of cells of the secondary batteries. These switches were used at the Crystal Palace Exhibition both with the Faure and Sellon-Volckmar batteries. Another modification of Mr. Hedges' principle is shown in

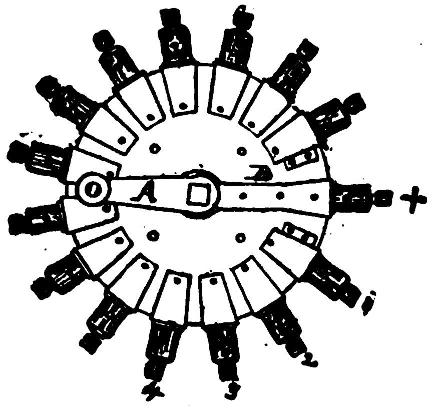

Fig. 2.

Fig. 3, which represents a reversing switch and shut off. Sir William Thomson has found that an action goes on in the incandescent lamp which tends to thin the carbon filament on the side where the current enters, and for this reason an alternating current has been preferred for these lamps. A direct current is, however, more generally used, and the disadvantage referred to can be removed by reversing the direction of the current occasionally. To do this, it is only necessary to connect the two terminals of the dynamo with those marked A and C in the drawing, the lamps being on this line connecting D and B. As shown the current will

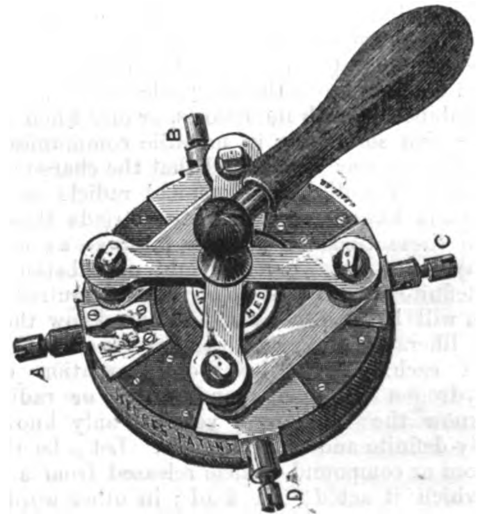

Fig. 3.

enter the lamp at B, passing from the positive terminal A through the contacts of the switch. By sliding the top contact on to B the connection with the positive terminal A is broken, and the current enters the line of lamps from the machine by means of the negative terminal C. The arrangement of these switches entirely does away with chance of setting fire to the wood block, which sometimes takes place with those where the contact piece simply slides off above the unprotected wood. They were exhibited at the Crystal Palace by the Electric Lighting Supply and Fitting Company, the sole makers.

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ELECTRICAL ACCUMULATORS OR SECONDARY BATTERIES.*

BY PROFESSOR OLIVER J. LODGE, D.SC.

(CONTINUED FROM PAGE 93.)

No. II.

A Planté and a Faure cell, though the process, and more especially the time, of formation is different, are, when formed, pretty much the same thing; and consist of two plates of lead, one coated with black peroxide of lead ($Pb\,O_2$), the other with a spongy material consisting of metallic lead in a fine state of division and more or less alloyed with hydrogen; both plates immersed in dilute sulphuric acid of about ordinary battery strength. Two plates in this condition must, as explained last week, give a current when connected by a wire, the positive current flowing along the wire from the peroxide coated plate—the + plate—to the spongy metallic — plate, and back through the liquid in the other direction; the spongy lead becoming gradually oxidised, and the peroxide reduced to some lower oxide, all the time the current lasts, *i.e.*, until the condition of the surfaces has become either temporarily or permanently the same. In order to bring the plates into the active condition they are first coated with oxide of lead, either electrically (by Planté) or mechanically (by Faure), which is then acted on by an electric current passed through the cell for some considerable time, the current being made to enter the liquid at the plate which is to be peroxidised, and to leave it at the plate which is to be reduced. Hence the former of these plates may be permanently labelled +, for when charging the cell the current enters at it, and when discharging the cell the current sets out from it. The other plate is similarly always —. There need, therefore, be no ambiguity about these terms. The + plate is always to be connected with the positive pole of the dynamo, whether the latter is supplying the current to the battery and charging it, or whether the dynamo is receiving the current from the battery and being driven by it.

Theory of Electro-chemical Decomposition.—It was stated last week that electricity was conducted through a liquid by means of two opposite processions of the constituent—dissociated—radicles of whatever substance in the liquid is undergoing decomposition, and that every such radicle possesses a certain definite charge of electricity which it carries with it and delivers up to the electrode, either when it is set free by combination with its fellows, or else when it is made to combine with something in metallic communication with the electrode. It was also stated that the charge of electricity possessed by a dissociated monad radicle is constant; and that diads have twice this charge, triads thrice, and so on. From these considerations it follows—as was proved by Faraday—that for a given weight of substance decomposed, a definite quantity of electricity is required; a quantity which will be known as soon as we know the number of atoms liberated, the electrical charge of each, and the weight of each. Let q be the dissociation charge of a free hydrogen or other monad atom or radicle. We do not know the value of q yet, we only know that it is perfectly definite and unchangeable. Let μ be the weight of any atom or compound radicle released from a combination in which it acted as a k-ad; in other words, let its active atomicity have been reduced by k, or let k be the number of bonds which have been broken in the act of making it a free radicle—whichever way of expressing it is preferred—then it is necessarily possessed of an electrical charge kq.

Let N be the number of such atoms delivered up to an electrode in any time, then in the same time a quantity of electricity $Q = N\,k\,q$ must have passed through the cell; and the weight of the substance liberated in the same time is $N\mu$—call this M. Then

$$\frac{M}{Q} = \frac{\mu}{k\,q}$$

Now, in the right hand side of this equation k is the only thing we know; we only know the relative weight of different atoms, not the absolute weight of any. Let h be the absolute weight of a hydrogen atom, and m the number ordinarily known in chemistry as "atomic weight," viz., the number which expresses the weight of any atom relatively to hydrogen, so that $\mu = m\ h$; then the above equation may be written

$$\frac{M}{Q} = \frac{m}{k} \cdot \frac{h}{q}$$

Now, though neither h nor q are yet known, their ratio has been determined by careful measurement, and it is 1·9505 in C. G. S. units; in other words, the electrical charge of a free hydrogen atom is 9505 times its weight in grammes. And the charge of any other radicle of atomic weight m and with k free bonds is $\frac{9505\,k}{m}$ times its weight in grammes.

If the weight of the substance be expressed in pounds, and the quantity of electricity concerned in its liberation or decomposition in ampere-hours—as for practical purposes is rather convenient—the above number 9505 becomes 12,020, or, with sufficient accuracy in ordinary cases, 12,000. So we will now repeat the above equation in an easy and practically useful form:—

$$\frac{\text{Weight of substance acted on in a single cell, in pounds}}{\text{Quantity of electricity passed through it, in ampere-hours}} = \frac{\text{ordinary "atomic weight" of the substance}}{\text{12,000 times the number of bonds released per atom of the substance.}}$$

Whether the "substance" is the constituent which is liberated at the positive or at the negative pole, or whether it is the original compound, which is not "liberated" at all but decomposed, matters nothing. The above statement is perfectly general and universally applicable. It applies also when it is recomposition that is going on instead of decomposition.

The expression "number of bonds released or joined per molecule" is not a happy one, but the phrase "change of valency" is no better, and the very simple meaning intended to be expressed is best conveyed by an example. Suppose $Cu\,SO_4$ is being decomposed; two bonds are released when Cu separates from SO_4, hence

$$\frac{\text{Weight of sulphate of copper decomposed}}{\text{Quantity of electricity passing through it}} = \frac{63{\cdot}5 + 32 + 64}{24{,}000}$$

But we might equally well write—

$$\frac{\text{Weight of copper deposited}}{\text{Quantity of E required}} = \frac{63{\cdot}5}{24{,}000}$$

Take as another example the decomposition of common dilute sulphuric acid, with copper electrodes say,

$$\frac{\text{Weight of hydrogen set free}}{\text{Quantity of E passed through cell}} = \frac{1}{12{,}000}$$

$$\frac{\text{Weight of sulphuric acid decomposed}}{\text{Quantity of E}} = \frac{98}{24{,}000}$$

$$\frac{\text{Weight of sulphate of copper formed at the expense of the oxygen electrode}}{\text{Quantity of E}} = \frac{159{\cdot}5}{24{,}000}.$$

Suppose nitrate of silver is the substance acted on. Here only one bond is released per molecule, so

$$\frac{\text{Weight of silver deposited}}{\text{Quantity of E}} = \frac{108}{12{,}000}$$

$$\frac{\text{Weight of nitrate of silver decomposed}}{\text{Quantity of electricity}} = \frac{170}{12{,}000}$$

Finally, suppose the substance acted on is Pb O, the protoxide of lead, then

$$\frac{\text{Weight of litharge oxidised to peroxide}}{\text{Quantity of E required.}} = \frac{223}{24{,}000}$$

* We reprint these excellent articles from the *Engineer*.

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Weight of litharge reduced to metallic lead, the same.

Thus a current of one ampere is able to oxidise on one side of a Faure cell $\frac{223}{24,000}$ lb. of litharge per hour, provided there is no waste, nor any gas given off, and to reduce the same amount on the other side. Or every pound of litharge on either side of a Faure cell requires 108 ampere-hours for its reduction and oxidation.

If instead of one cell a number n are taken and arranged in series, and current sent through them, all the above action goes on in each cell, so of course the total decomposition will be n times as great.

No. III.

To understand fully the action going on in a Faure cell it is necessary to know something about the salts of lead, for at the present time lead seems by far the most suitable material for secondary batteries.

The protoxide of lead is called litharge, and is of a yellow or puce colour. Its constitution is Pb O, and its atomic weight, therefore, 223. The intermediate oxide is red lead, or minium, and its constitution appears to vary from $Pb_2\ O_3$ to $Pb_3\ O_4$; but it is most commonly the latter, and its atomic weight, therefore, 685. The peroxide, or black oxide, or heavy lead ore, is $Pb\ O_2$, atomic weight 239; and it differs from the two preceding oxides in being a conductor of electricity, just as the peroxide of manganese $Mn\ O_2$ is.

The sulphate of lead, $Pb\ SO_4$, is also important in the present connection. It is a dirty white non-conducting substance, slightly soluble in strong sulphuric acid, but quite unsoluble in dilute acid and in water. It will be formed, of course, as soon as red lead or litharge are put into dilute sulphuric acid; and unless there is an excess it may happen that all the acid gets used up in this way, leaving only water, in which case the liquid will cease to conduct. A Faure cell must, therefore, contain a considerable space for the acid liquid in addition to the space occupied by the plates and their coatings. But even then the strength of the dilute acid will become gradually weaker if a new Faure cell is allowed to stand for some time before a current is sent through it; and its resistance will accordingly be pretty high when you begin to charge. While the current is passing, however, the $Pb\ SO_4$ formed while standing will be gradually decomposed, the lead being either reduced or oxidised, and the acid being reformed; so that the resistance of the cell will gradually diminish for this reason. It will also diminish for two other reasons, one of which is that the liquid is warmed by the current, and the average number of dissociated atoms thereby increased; while the other is that the spongy lead formed on the — plate, and the peroxide formed on the + plate, are both conductors; and hence the acting surfaces of the plates are practically slowly advancing to meet each other all the time the current is charging the cell, and the layer of non-conducting oxides and sulphate is gradually diminishing in thickness. Hence the urgent necessity for the flannel or felt between the plates. For if ever in the process of charging, any portion of the peroxide were to reach across to a portion of the spongy lead, a bridge of metallic conduction would be completed, and the cell would be short circuited. It would be as reasonable to try and charge up a bit of copper wire as such a cell.

We perceived in the last article that a current of one ampere was able, in 108 hours, to oxidise a pound of litharge to peroxide on the positive plate of every cell through which it is passed, and to reduce a pound to metallic lead on the negative plate in the same time.

The oxidation of a pound of minium ($Pb_3\ O_4$) to the peroxide can be effected by a rather less quantity of electricity, namely, by $\frac{48,000}{685} = 70$ ampere hours; there being four bonds joined up when $Pb_3\ O_4$ is oxidised to $3\ (Pb\ O_2)$. But to reduce minium to metallic lead requires a greater quantity—eight bonds having to be loosed—namely, $\frac{96,000}{685} = 140$ ampere-hours. Hence, provided there is no waste and no gas given off, twice as much minium will be oxidised in each cell by a given current as is in the same time reduced. But with litharge the quantities oxidised and reduced are equal. When minium is used, therefore, either the coat of it on the + plate must be considerably thicker than the coat on the negative, or else the + plate itself must be expected to be eaten into somewhat before the reduction on the other plate is finished, and must be made of sufficient thickness to stand it.

Every pound of metallic lead thus oxidised to peroxide will require $\frac{48,000}{207} = 230$ ampere-hours of electricity.

If any gas is given off, every pound of hydrogen collected accounts for 12,000 ampere-hours; or, as a pound of hydrogen occupies about 180 cubic feet under ordinary circumstances, we may reckon the electricity necessary as 67 ampere-hours per cubic foot of hydrogen. If any free oxygen is detached, the electricity may be reckoned at the rate of 134 ampere-hours per cubic foot, or 1,500 ampere-hours per pound.

Now let us take a single Faure cell charged with minium, and pass through it a measured current of C amperes for an observed time of T hours. Let the gas evolved be collected, and found to consist of h cubic feet of hydrogen and g cubic feet of oxygen. Let the weight of minium reduced to metallic lead on the negative plate be called x, and the weight oxidised to peroxide on the positive plate be called y, both being expressed in pounds avoirdupois. Further, let z pounds of the + plate itself be oxidised to peroxide; let a small quantity, say u pounds, of hydrogen remain associated with the negative plate, either mechanically as bubbles, or as a sort of alloy; and let v be the weight of oxygen likewise liberated but unable to escape, or else used up in some indirect way. Then the following two equations render a full account of all that has gone on, as far as electrical laws can express it:

$$C\,T = 70\,y + 230\,z + 1,500\,v + 134\,g$$
$$C\,T = 140\,x + 12,000\,u + 67\,h$$

The quantity g is probably zero if a properly weak current has been used in charging. The quantities u and v will also probably be small;* and, therefore, perhaps, for practical purposes it may be sufficient to write.

$$C\,T = 70\,y + 230\,z$$
$$C\,T = 140\,x + 67\,h$$

Now h, the volume of gas evolved, can be easily collected and measured. There remain then the three unknown quantities $x\ y\ z$. The above two equations are, of course, not sufficient to determine them, but they show us the kind of relation which must exist between them, on the hypothesis that u and v are negligible. Especially we learn how much the + plate will have been attacked at any time after the whole of its minium layer has been reduced.

The most direct way of determining C T is to insert in the circuit some kind of voltameter, say a couple of large copper plates immersed in a solution of sulphate of copper; then by the time that one of the plates has gained, and the other lost, P pounds in weight, the quantity which has passed will be

$$C\,T = \frac{24,000}{63{\cdot}5}\,P = 377\,P \text{ ampere-hours.}$$

* They are multiplied by large coefficients though, and I am by no means sure how far it is practicable to neglect them. I believe the reduced lead is alloyed pretty strongly with hydrogen.

Electric Lights in Rhode Island.—An important Act passed the General Assembly which will seriously affect electric lighting and telegraph companies. Several Acts were introduced for the incorporation of electric light companies, but the committee to whom they were referred inserted a clause by which City and Town Councils may order poles and wires down after a formal notice of thirty days.—*Engineering News*, New York.

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ECCENTRICITIES OF PATENT LAWS.

We have already commented at some length upon several nice technical points which were judicially settled in the Glasgow telephone case, but which, nevertheless, were not scientifically settled. There remain some other points, not so nice, perhaps, but far more curious, which the law has pronounced upon, but which nobody can regard as being equitably disposed of. Litigation has often been likened to a lottery; but litigation in respect to patents would seem to partake more of the nature of surprise packets, with the additional drawback that even if you have the luck to select the sweetstuffs containing a coveted gold ring, as likely as not the policeman steps in and condemns your prize and the whole proceeding as a technical breach of the law. We have heard of the Welsh jury who gave a verdict of not guilty, but don't do it again; it is reserved for judges in patent cases to inflict heavy penalties while pronouncing a verdict of acquittal.

This, we imagine, was the universal opinion of laymen who read the admirable summing up of the learned judge in the recent trial—that portion of it, we mean, relating to the infringement of Edison's patent. Everything was clear and logical throughout the whole length of this remarkable judgment—except the verdict. For a long time nobody could discover any connection between the two; but on careful search it became evident that Mr. Edison had been guilty of the grave offence of saying too much, or too little, in his specification, and that his patent was, consequently, invalid—at all events for the moment. We are not presuming to question the law, still less to criticise the judgment itself; we are only commenting on the eccentricity of the law, and the unenviable position of men like Mr. Justice Fry who have to administer it.

That a patent should be exposed to wholesale invasion because of a simple informality, in the which a patentee is usually at the mercy of his agent, is curious enough; but when we are told that the informality can be rectified, though the infringement cannot, the situation becomes ludicrous. Hunnings's transmitter is judicially a piracy; but as the thing pirated had no technical existence, the pirate was let off. What will be the status of the captured prize when the owner establishes his rights—if ever he succeed in doing so? And how about the prize-money—that is to say, costs?

But the oddities of the case do not end here. We have called Hunnings's patent an infringement of Edison's. The judge has said so; and technically, no doubt, he is right. But does anybody seriously believe that it is so in fact, either morally or scientifically? If Edison's lampblack is a tension regulator it is a very bad one, and even as such could not be called original; whilst if Hunnings's coke is a tension regulator it is original only in its absurdity. The essential value of both these devices was not in their regulating the current, but in the newly-discovered fact that currents could be regulated so as to convey an exact counterpart in miniature of human speech; and this discovery was not the discovery of either Mr. Edison or Mr. Hunnings. Any new form of incandescent filament can be patented, it is said; why not any new form of tension regulator, the generic tension regulator itself not being patentable?

But, leaving this recondite point for the lawyers, we are next struck by the comical fact that whereas the one claimant who is judicially, though not technically, successful in this suit has not been at all successful in the practical application of his invention, on the other hand the invention which is declared to be merely a colourable imitation has been eminently successful. The counterfeit is really of some use, the original is of next to none. The materials patented by Edison are discarded as practically worthless, and material identical with that patented by the defendent, but legally condemned in his hands, has been substituted. For the upholders of our patent laws as conducing to improvements this is a hard nut to crack. Either Mr. Hunnings has a right to his improvement, or the public have a right to it without Mr. Edison's leave.

But this does not exhaust the tale of anomalies. We have hinted that, in our opinion, lampblack was a mere makeshift, and not a very ingenious one, to modulate the current. Once know the effect of modulating it by the impact of sonorous waves, there are a hundred ways of producing the effect. Reis did not quite realise the conditions; we owe their discovery to Graham Bell. A later discovery revealed the fact that light contacts would act as well, or almost as well, as a tympan for translating vocal sound into corresponding electrical current. But this discovery was Professor Hughes's; and not that of either Edison or Hunnings. Whatever may be said of the transmitter claimed by the first-named of these two litigants, that contrived by the latter is plainly an adaptation of Hughes's microphone—is, in truth, a heap of microphones fortuitously encased. Yet the microphone is not a patented property! Thus we have the phenomena of one person who infringes an idea which is not patented

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being sued for infringing a third person's idea—not because it is really his, but because he happens to have patented its application. If Professor Hughes had patented his microphone, the Hunnings transmitter might have been held to be an infringement of, though undoubtedly a serviceable improvement upon, it. But in any case Mr. Edison could not have sustained an action against Professor Hughes, nor, consequently, against Mr. Hunnings. The rights of patentees are, doubtless, very sacred; if only they could be strictly defined they would, probably, be inviolable. But, unfortunately, the patent laws do not—no patent laws ever can—rigidly define them. Much must be left to the chance of a lawsuit, to the accident of evidence, and the cleverness of professional patent agents. Your ring may be genuine gold, but if the experts say it is brass, brass to all intents and purposes for you it must remain; on the other hand, be it never so brazen, it will be as pure gold to you if only fortune and the law-courts favour. These are the ordinary risks of patentees we suppose, but they are exceedingly expensive; and, from the public point of view, it is, perhaps, not such a laughing matter that a best possible telephone is not to be had without paying not only the price of it, but the cost of all this litigation into the bargain.

CORRESPONDENCE.

WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I will leave personalities alone, as the special function of Mr. Johnstone, and would point out to that gentleman that he, by descending to them, weakens his authority as an experimenter.

Again I ask, what justification has Mr. Johnstone for concluding that, because a current proceeds from the outside of his jar, on the inside being charged, *therefore* "electricity is *matter* and it has passed *through* the glass?"

If I speak to him through a window, and though he by "experiment" prove that it is veritably my voice and none other, is he justified in concluding that *my voice is matter*, and has *passed through* the window pane?

If, by exercise of that force, known as "the will," *I will* my outstretched hand to open and shut, is "my will" *matter*, and has it passed *through* my arm?

Mr. Johnstone concludes again that I am evidently "an advocate of two electricities," and again errs in his conclusions. To my mind it is a confusion of terms to speak of two or even *one* electricity; and the line of argument I have taken up against Mr. Johnstone's theory should show him that in the word electricity I recognise only a figure of speech conveying the idea of an active agent producing certain effects which we call electrical; that all matter is in a statically electrical condition until that equilibrium is disturbed, when the phenomena of electrical action appear.

Quoth Mr. Johnstone, "Where does the current come from which passes from E to H?" I will put another—Where does the voice come from which reaches Mr. Johnstone's ear from my side of the window?

I am asked, "Why does flame F stand upright when the jar is fully charged?" I reply, because the current has ceased to flow, as Mr. Johnstone may demonstrate by touching the jar with an earth line, when the flame will bend down again, of course.

Does Mr. Johnstone think he can bottle up electricity with a paraffin plug? Can he expect to fully charge a jar using a point for a knob? He might as reasonably expect to empty a well by pumping into a leaky trough which returns its contents to the source.

The only argument adduced by Mr. Johnstone that strikes me as sounding fair is, "that different samples of glass produce different results, some even failing to retain a charge at all."

But it is only sound—why is the charge not retained? Because it is neutralised by reunion, through, or over the surface of the glass, which has conductivity, owing to imperfection of quality or age.

The glass of Mr. Johnstone's jar is non-conducting, so he must not appropriate this argument as an admission in his favour.—Yours, &c., D. HARBORD.

Redhill.

THE TELEPHONE CASE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the generally accurate report of my evidence in the case of the United Telephone Company *v.* Cox, Walker, and Co., given in your last number, there are some typographical errors which are obvious, and a few blunders on the part of the reporter which perhaps you will allow me to correct. I did not say "a make and break instrument can only transmit the speech," but "can only transmit the *pitch*." A little further on (top of the first column on p. 116), "plate transmitter" should be "Blake transmitter." The middle of the same column, "cocks in the centre of each horn-electrode" should be "corks," and "plates of glass bedded," &c., should be "plates of brass." In the end of the same paragraph, "shaping" should be "shaking," and the word "speaking" should be inserted after "the most beautiful."

The description of the transmitter referred to in the foregoing paragraph is made unintelligible by the transposition of a full stop from after the words "placed behind," where it should be, to the next line (twenty-eighth from the top of p. 116) between the words "thick" and "the coke," where it should not be.—Yours, &c., W. F. BARRETT.

RESISTANCE OF A VOLTAIC ARC.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Would you or any of your readers be good enough to inform me what is the resistance (approximate) of a voltaic arc produced by fifty Grove pint cells, the carbons $\frac{1}{4}$in. in diameter, and each of them three or four inches long, and also the probable internal resistance of a battery of fifty cells, the platinums $2\frac{1}{8}$in. wide, nitric acid sp. gr. 1·4, the sulphuric solution one part acid (by measure) to 7 parts water?—Yours, &c., T. T. G.

SOME REMARKS ON ELECTRICITY AND PETROLEUM AS COMPETITORS OF COAL GAS.*

The remarks I have to offer to-day will be more of a practical than a scientific character. In the first place, I have tried as much as possible to divest myself of the prejudices on this subject which are common to gas men who have followed the business during the greater part of their lives. It is, perhaps, only natural that gas men should think that, what they have so long considered the very best agent for the purpose of illumination, cannot be superseded by anything new. At any rate they are not likely to become the first converts to new-fangled notions, but to be very conservative in their opinions, and reluctant to adopt the new faith in place of the old one. In fact, men who are worth their salt will not adopt it, until they have tried every means at their disposal to prove that their faith in the old ship is not without reason, and they will bring facts and arguments in support of it. To my mind, the most potent fact or test in this nineteenth century is that which will pay best, and is most convenient for public use. Men may talk and rant as much as they like, have as much newspaper puffing and

* A Paper read at the meeting of the Gas Institute last week by Mr. John Chew.

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advertising as they can afford, but it will be only like a flash in the pan. If the thing does not pay it will not do.

It is with a feeling of this kind that I am induced to offer these remarks to-day. I do not wish to overvalue coal-gas as a lighting medium when put in competition with electricity or petroleum; nor, on the other hand, do I wish to undervalue the latter; to do so would be very unwise. I think, however, we should view the matter fairly all round, knowing as we all do, the early history of gas lighting, and the difficulties it had to encounter in making its way in public estimation three-quarters of a century ago. Most of us know so well what enormous sums of money were wasted before gas lighting began to pay, that we need not be surprised that in these days, when there is so much more wealth in the country, a portion of it should be freely spent in bringing electricity to greater perfection. Speaking of electricity, if you ask what it is, all I can say is that you cannot be told, any more than you learn what it is that gives the vital influence to the nervous system in human beings. We are sensible that it exists all through nature—in the air, in the earth, in water, and in human beings. We know that there are electric currents, and even electric storms or commotions, as there are storms of wind. In proof thereof I have only to point out to you how often you may read in the newspapers that a derangement has taken place in telegraphy, owing to the direction of the current being diverted by the prevalence of an electric storm in some particular district.

We know that in recent years great progress has been made in gathering, or, more properly speaking, diverting or generating electric currents, and using them for purposes of illumination, &c.; but we now safely say that we have almost reached the highest point of efficiency attainable in this department, as the generating machine gives out electromotive force to within 10 per cent. of the power applied. I need not here describe an electric depot, nor how the current is, so to speak, made to do work and yield light as the result. Those of you who visited the Crystal Palace Exhibition are sufficiently well familiar with the gas and steam engines and boilers used, and the results given out. A little farther on I may, however, give some particulars of the generating station fitted up by my department at Blackpool.

The various installations of electric lighting which have taken place in town and country up to the present time have been made with the conducting wires either overhead or underground. When wires are suspended in the air from poles or lamp-posts, they resemble telegraph lines, though they are much more dangerous should any happen to break while working. This fact alone will be detrimental to the adoption of all systems of overhead wires, and underground wires must of necessity take their place, inasmuch as you have then perfect immunity from danger to the public in the streets. The reason for employing overhead wires is not far to seek. It has been an endeavour to make the installation cost as little as possible. If the wires are to be laid underground, an expensive coating for insulation has to be resorted to; and to the cost of this has to be added the cost of the pipes and the laying them in crowded thoroughfares. The price of a bare conductor will be only one-half or one-third that of a properly insulated one prepared for being laid underground. Our first experience at Blackpool was with underground wires, to which the sea water percolated, damping and rotting the light covering which had been placed over them, and which would otherwise have been sufficient, until the whole of the current became lost, or, technically speaking, "made earth."

It is now nearly three years since we obtained power from Parliament to spend a sum of £4,500 on electric lighting, with a provision that the whole was to be repaid back, by means of a sinking fund, in ten years. We have accordingly spent £3,500 of the amount named, and have for this sum a generating depot about 1,300 yards from the farthest light, with two 16 horse-power (nominal) engines and boilers, with ten of Siemens's 6,000 candle machines, each of which absorbs about 4 horse-power. From this depot are supplied the nine electric lights, the whole of which are said to be equal to 54,000 candle-power when at their best. These are fixed about 60 feet high in clear glass lanterns, having reflectors, 4 feet in diameter, at distances varying from 180 to 400 yards. The wires are at present carried overhead, for the reasons before mentioned. You will, I am sure, excuse me if I say that I have not myself seen, in London or elsewhere, anything to equal this lighting in brilliancy and effect. As the lamps are fixed in the centre of the Esplanade fronting the Irish Sea, they are seen at distances ranging from 15 to 25 miles, and undoubtedly form a very charming attraction to our seaside watering-place. We have not adopted these lights with the object of saving on the cost of gas, but rather with a view of keeping our town in the front rank of watering-places. The Corporation are not at all sparing in the use of gas, for in our 20 miles of streets we have 650 gas lamps, including 30 or 40 of Bray's and Sugg's of from 60 to 100 candle-power. I will shortly give you the working charges on our electric plant, with a view to making some comparisons as to how the electric light may compete with gas; but the difficulty in which I find myself is to tell accurately the photometric power of the lights, as so many different estimates are made by different makers. Taking, for instance, the lighting of the City of London, and comparing the Brush and Siemens systems, the lamps of the former are put forth as being of 2,000 candle-power, and those of the latter as being of 300 to 400 candle only, yet, to an observer, it is very difficult to see which gives the best illumination, though the contrast ought to be as striking as it would be between a street lighted by ordinary gas lamps and one lighted by the improved lamps of 100 candle-power.

During the year ending March last we worked our lights for 25 weeks of seven nights each, or a total of 175 nights, being equal to 600 hours. The cost of this was as follows:—

	£	s.	d.
Wages	£179	15	0
Coke, water, and gas	63	19	2
Oil, waste, tallow	6	3	11
Carbons	51	0	3
Ground rent	15	0	0
Tradesmen's accounts for materials for the repairs of lanterns, engines, machines, wires, insulators, posts, and paint	125	11	9
Total	£441	10	1

The above charges are different from those of the previous year by about £20, arising from our having to renew two of the high poles; so that we may safely say that the working and maintenance charges are a fair average for the two years, or rather two seasons working. The total of the expenses, less interest, being £441 10s. 1d., and the number of hours burning 600, this is equal to 14s. 8d. per hour; to which must be added interest at, say 5 per cent., amounting to £175, or equal to 5s. 10d. per hour. As, however, only the same interest would be payable if the lights were burning a greater number of hours—or, for the purpose of comparison, say 1,800 hours, which is the number of hours our gas lamps are in use—this would then reduce the rate to 2s. per hour, instead of 6s.; therefore the total cost would be 16s. 8d. per hour for sustaining what is called 54,000-candle illuminating power.

The next point is to consider whether there is 54,000 candle-power, and to get an approximate idea of what illuminating power each light actually possesses. I lately made a test of one of the electric lights against one of Bray's 60-candle gas lamps, which happens to be situated at a convenient distance from and in direct line with the light, and the result was that the average illuminating power was about 3,000 candles, or at the rate of 750 candles per horse-power, which was as near as I could ascertain with the rough apparatus at my disposal. Owing to the colour of the light the ordinary disc photometer could not be used, and I had to arrange for throwing a direct shadow upon a white ground. The light from the arc is so variable at times, although it is scarcely perceptible to the ordinary eye, that it was with difficulty that I could tell for any length of time the exact position for the meeting point. I have no doubt, however, that if the electric light had been on the ground, and under control for the fine adjustment of the arc during the test, a much higher result

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might have been attained; but this may be taken as a working test, though it is possible to get 1,500 candles per horse-power in experiment.

I will now put this result in comparison with coal gas, which in Blackpool is produced of from 18 to 20 candle-power, and sold at 3s. 3d. per 1,000 cubic feet; but if the Corporation were content with 5 per cent. interest only, it could be sold at 2s. 3d. per 1,000ft.; and seeing that I have put the electric light at this rate of interest, it is only fair that I should put gas at the same rate. This would work out as follows:—To produce gaslight of 27,000 candle-power, which will be that produced by the nine electric lights, would require say 27 gas lamps, each of 1,000 candle-power. These would consume 7,500 cubic feet of 18-candle gas per hour, which at 2s. 3d. per 1,000ft. would be equal to 16s. 10d. To this must be added the cost of cleaning, lighting, and repairs, at say 30s. per lamp for 1,800 hours, which on 27 lamps is equal to £40, or at the rate of 5s. 3d. each per hour; making a total of 17s. 3d. as the cost of gas against 16s. 8d. for electricity, or a difference in favour of electricity of 7d. per hour. You will see, then, that for large lights, such as those we use, electricity apparently would cost less; but it has the disadvantage of being a concentrated light, and cannot as yet be economically divided into small ones. A light of the power we use is too large for ordinary lighting, as you cannot obtain from it its full advantage.

To divide this light of 27,000 candle-power into incandescent lamps, so as to make them suitable for houses and streets, a very much larger outlay of capital would be required for plant to produce the same lights. If we were to use our own apparatus—that is to say, the engines and dynamo machines—as a generating station for the production of incandescent lights, we should have from the 40 horse-power developed, and the generating machines at the rate of ten 16-candle lights for each horse-power, equal to 400 lights for the whole of the total power of 6,400 candles, instead of the 27,000 we get from the arc lights. This is not one-fourth part of the amount of light we obtain from the arc system, taking the latter at half the amount stated by the makers of the appliances, and the incandescent light at the full value stated by them. What it would be if we had generating stations distributed about the town, and conducting wires laid in the streets, I could not even guess. It was recently given in evidence by Dr. Siemens, before the Parliamentary Committee on the Board of Trade Electric Lighting Bill, that to supply 2,000 horse-power value of light would require a capital of £100,000. This amount worked out at the usual rate of 10 lights per horse-power, each 16 candle-power, would give a total of 320,000 candles, being at the rate of 6s. 3d. per candle. However, Mr. Johnson, the agent of the Edison Company, gave 33,000 lights of 10 candle-power, or 330,000 candles, for £100,000, which will be found to work out to a little more than 6s. per candle. Applying the same figures to our own apparatus as above stated, the capital works out to 10s. 11d. per candle.

Certainly electric lighting seems very far from being within the range of practicability at present, notwithstanding all the advances it has made within the last three years. A great deal has been said about gas-engines being made the motive power for driving the generators, and about this being the most economic method of applying it. Perhaps it is; but those who have bought good gas-engines know that there is not much, if anything, gained in the outlay, in the first instance, between the cost of them and an engine and boiler worked by steam. The gain would be in superintendence. Who are the people likely to use the incandescent light in their houses? The most wealthy, to whom money is not an object. It will never do, however, to set up works to supply only the wealthy in a community. When the Electric Lighting Bill has passed through committee I trust the responsibility of maintaining a supply of gas will not be enforced by the Legislature. Where an electric light company competes with a gas company let them have a fair field, under the same conditions, and no favour; then the old doctrine of the survival of the fittest will put one or other into its proper place.

I am not surprised that the Brush Company and its offshoots declare large dividends, and that their shares command so great a premium. I do not see that they are doing much beyond acting as makers of a special class of machines in which they have a monopoly. As long as the public will buy their apparatus at present prices, this will continue. The district they light in London is the best and cheapest advertisement they could have. The "tall talk" of this company, and that of Hammond and Co., just floated, surpasses anything I have read out of America. If any one will read the speech delivered by Mr. Hammond at the Cannon Street Hotel, on the 18th of May, at a sort of statutory meeting of the Hammond Company, he will be treated to such a specimen of brag and bunkum that I should have thought no body of commercial men could have digested. People are investing their money now in these electric light companies as they have often done before in South American stocks, Turkish bonds, lead mines, and salted gold and silver mines. From the last return I have seen, from January to May 20, electric light companies have been registered with authorised capitals amounting to over £9,000,000 sterling. This certainly indicates that there is more capital in the market than can be employed in legitimate trade, and seeing that there is no fair opening that promises a profit, it must be recklessly employed to blow out a large number of bubble companies that will never exist anywhere but on paper and as a medium for share speculations.

Speaking of the electric light as it is, one would suppose that people think no improvement tending in the direction of reduced prices for gas is possible. I must differ largely from this opinion. If the capitals of so many companies and corporations can only be brought to bear a rate of interest that is now ruling the money market, it will not be one town alone that will supply gas at 1s. 9d. per 1,000 cubic feet, with 5 per cent. interest on capital expended, and nothing taken off the price to go in relief of rates, and new and improved apparatus erected at a less cost than formerly; and although great improvements may hereafter take place in the supply of electricity, there is plenty of room for it before it will be able at all to compete with coal gas. So far as it has gone it has benefited the suppliers of gas by calling into requisition a need for a greater quantity of light, and, as a result, more gas, and more capital at a low rate. I am willing to concede that many shareholders who have become possessed, by purchase or otherwise, of 10 per cent. stock, for which they have paid a price that will only yield 5 per cent.—particularly if it be in companies with inflated capitals and high-priced gas—are likely to suffer, as also will corporations who have bought too dearly be deceived in expecting to relieve the rates by their purchase; but we, as a body of gas engineers, are bound to do everything in our power to produce a cheap and good quality of gas suited for all the various uses to which it will be hereafter applied, and, in so doing, fear no competition from electricity, as it will stimulate us, by healthy competition, to push on to still greater improvements than any we have made in the past. When I undertook to write this paper I purposed saying something about petroleum as a competitor of coal gas. I think the subject worthy of some attention at our hands. There can be no doubt whatever that in many small towns in the country petroleum is a much more formidable competitor of coal gas than electricity, especially in the houses of the working classes. But perhaps I had better give you some particulars of my own experience in its use for street lighting purposes, seeing that during the whole of the past winter I used it for the supply of more than fifty lamps in a portion of our district in which we had not the power to supply gas. This part of our district was added to the borough about three years ago, and was quite rural in its character, and not likely to have fifty consumers for the next ten years to come; but we found that a particular portion of the district had been annexed by a small gas company some five miles away. There was nothing but farmhouses on the road for that distance, and the company had not laid any pipes up to that time, and what we considered a fair offer of compensation was made to them to surrender their right to supply gas, but they declined. Since then we have not been able to agree to any terms, and have, therefore, set up lamp-posts every fifty yards through

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the whole of the village, fitting up the posts and lanterns. Several kinds of petroleum lamps were tested for the purpose, and ultimately I decided to recommend the Silber Light Company's street lamps. As I go on I will give you the figures as to the cost of this undertaking for lighting during the past winter; the period of the cost to which I am about to refer to is from October 30th to April 30th—six months. The lamps were lighted shortly after sunset, and put out at twelve o'clock at night, and left out altogether for five or six nights about the time of full moon each month. The total number of hours during which they were alight was 962. The illuminating power of each light was equal to 10 or 12 candles, and I may say the lamps have been very satisfactory to the people for whose benefit they were up. You must not suppose by this remark that I consider them equal to gas lamps; but on account of their being oil lamps they were placed closer together than gas lamps usually are. In small country villages, from 70 to 100 yards, or even more, is not an uncommon distance for gas lamps to be placed apart, even when 14 or 15 candle gas is supplied.

After the first month or two, when we had removed certain little defects here and there, I did not have anything like the trouble I had anticipated with the petroleum lamps. Too much or too little air getting access to the lanterns would sometimes make them smoke, and at other times cause them to be blown out. The result was that I found they required double the amount of labour and attendance in lighting, keeping clean, and trimming, that an ordinary gas lamp does; but having made up my mind that they should succeed, the cost of extra labour did not deter me from going on with them. After making the closest inquiry, I find that out of the 54 lamps we had in use, it was very seldom that there were more than two or three out, or even doing badly, on any one night. Had I not made this experiment myself, I should have doubted very much that they would have done so well as they did; but having now tried it, I feel sure that, whether it be on the score of expense or the quality of the light, it is a dangerous competitor with coal gas for street lighting in any small country village, where gas is both dear and of poor quality.

The details of the expenditure in connection with the petroleum lamps are as follow:—

Outlay in capital account for 54 posts, fitted with lanterns and Silber oil lamps complete	£156	8	0
Expenditure for cleaning, lighting, and repairing	49	7	2
Petroleum oil	22	6	11
Six months' interest on capital at 10 per cent ...	7	16	0
Total	£79	10	1

This works out pretty nearly to ·37d. per hour for each lamp. The oil I used was of different prices. At first I thought I would get the highest, "Water White" brand. This was 1s. 4d. per gallon for casks; but I found this to be no better than the quality I am now using. It is what is known as the "Royal Daylight" brand. For this I gave 11½d. per gallon, but it is now offering at very much less—in fact as low as 8d. per gallon for casks—and it may be bought retail at 3½d. per quart, or 1s. 2d. per gallon. The price, of course, varies with the season of the year; but I have given the highest and lowest prices at which I have bought.

In judging of oil as a competitor with gas, this broad fact meets you—that a good oil lamp of the best make (we give 11s. 6d. each for ours) will give a light, taken roughly, of 10 to 11 candle-power, and consume in 20 hours one quart of oil, costing 3½d. at the retail price, whereas 100 cubic feet of coal gas, costing 5d. at 4s. 2d. per 1,000 feet in country towns, will give a light for 20 hours of from 14 to 16 candle-power. I have given these latter figures of quality and price at perhaps a fair average in each case. I had not the means at my disposal for testing the exact photometrical value of the kind of oil lamp I use (the size and make being inconvenient for placing it in the bar photometer) except in a very rough way; but I tested it sufficiently near for practical purposes.

When we consider the foregoing facts, it is not to be wondered at that the workman and cottager use oil instead of gas, when it is brought like milk to his door, and retailed in the smallest quantities. He cares nothing about the slight smell it gives off, and the trouble of trimming his lamp is not of much account, when his hands are already soiled with his day's work. A good workman's lamp can be bought for 1s. 6d., and this is all he requires. Under these circumstances, he will not trouble the gas company much, and for myself I can safely say that I do not regret it; for the collection of accounts from this class of customers, the trouble of inspection, and removals from house to house, the turning off and on of the gas for every change of tenancy, the takings and repayments of deposits, with allowance of interest at 5 per cent. we are compelled to give, cause no end of trouble and expense, which is scarcely compensated for unless these consumers are charged a higher price for what they bring to the rent-roll.

Having now made all the remarks that occur to me on the subjects of my paper, and put them as briefly as I could before you, I leave them in your hands.

PHYSICAL SOCIETY.—June 17.

The Physical Society met in Oxford by invitation of the President, and, after luncheon, in the hall of Merton College, by kind permission of the Warden and Fellows. The health of the Society was proposed by the President, and responded to by Lord Rayleigh. The usual meeting was then held in the Clarendon Laboratory, Professor Clifton, president, in the chair.

Dr. W. H. Stone exhibited and described an electro-dynamometer specially designed for measuring the currents used in the medical applications of electricity. For this purpose a light suspended coil is an advantage, and Dr. Stone adopted aluminium, which, with equal conductivity to copper, weight for weight, is very much lighter than copper. No frame was used for the coil, which was tied up with silk and varnished, amber varnish, such as used by photographers, being recommended by the author for this and similar purposes as preferable to shellac. A bifilar suspension of the coil was adopted to give directive force to the coil, the threads being of silver gilt wire, drawn after gilding, and such as is used in making gold lace. It is preferable to platinum wire by reason of its lower resistance. Silver gilt wire, $\frac{1}{500}$in. in diameter, has a resistance of 9·8 ohms per metre; whereas platinum, of same dimensions, measures 62·2 ohms. Aluminium wire can be drawn as fine as copper. Some difficulty has hitherto been experienced in making contacts with it for electrical purposes, but Dr. Stone believes he has overcome them. The gilt wire makes a good contact with it. The specific heat of aluminium is high, and hence it is recommended by the author for resistance coils. The threads of the suspension were hung from two little brass springs, placed horizontally in line, and capable of being adjusted to and fro so as to widen the distance between the points of suspension when necessary.

Mr. Varley, Professor Perry, and others offered some remarks.

Mr. Bosanquet then described his application of the Faure accumulator charged by a dynamo-electric generator to the working of laboratory apparatus instead of the usual Grove or other battery. The net result of his experiments is that the accumulators charged for two hours have sufficient energy to keep the apparatus employed running for a week, and hence it is unnecessary for him, as heretofore, to put up thirty Grove cells each day.

Professor Perry observed that a well-made Faure cell having the minium laid on in a uniform coat does not loose its charge nor develop local action as is done by those accumulators in which the minium is put into holes in the plates.

Professor W. G. Adams then took the chair while Professor Clifton described some ingenious devices adopted by him in lecture experiments on electrostatics. These consisted of insulating glass stems, with glass cups to hold sulphuric acid formed on the stems; also a form of key which by rapidly-succeeding contacts brings the spot of light on the electrometer scale to rest without tedious swinging. He also described a form of lecture galvanometer, sine or tangent, which could be readily shown in all its working to a large class, and exhibited a simple and inexpensive apparatus for measuring the focal length of a lens in six different ways, according to what is known about the lens. The results showed that the apparatus was very accurate in its indications.

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THE CRYSTAL PALACE EXHIBITION.

(CONTINUED FROM PAGE 114.)

Post Office Exhibits.

Between the double-needles is one of the same kind in principle, having a handsome Gothic case. It was made by W. Reid, mechanist, 25, University-street, London, and used at the House of Commons. The two-needle instruments required a pair of wires. The single needle, which follows in order, performs its functions with only one wire.

A large assortment of historical apparatus is here collected, old and new insulators, including Cooke's goose quill, used on the first *actual* telegraph line between Paddington and West Drayton in 1838, together with lightning protectors of various kinds. We then come to several kinds of batteries, amongst them being Varley's zinc-carbon *secondary* battery (1862), which was used at the central station (London) for distributing time signals. Specimens of Post Office submarine cables, a piece of the first cable, as well as a length of the first Atlantic cable are shown; as also a pretty model of a cable repairing ship, designed and skilfully made by Mr. W. R. Culley, of the Submarine Department, G.P.O.

Several instruments are working—the Wheatstone A B C (Fig. 6), single needle (Fig. 7), single or duplex ink-writers,

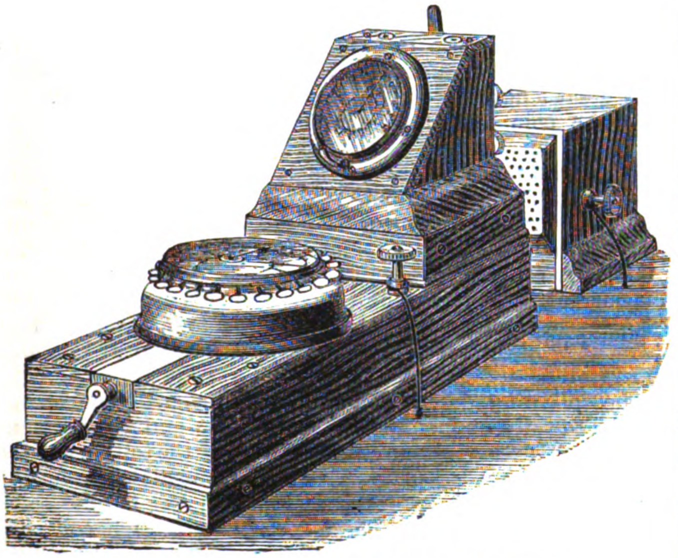
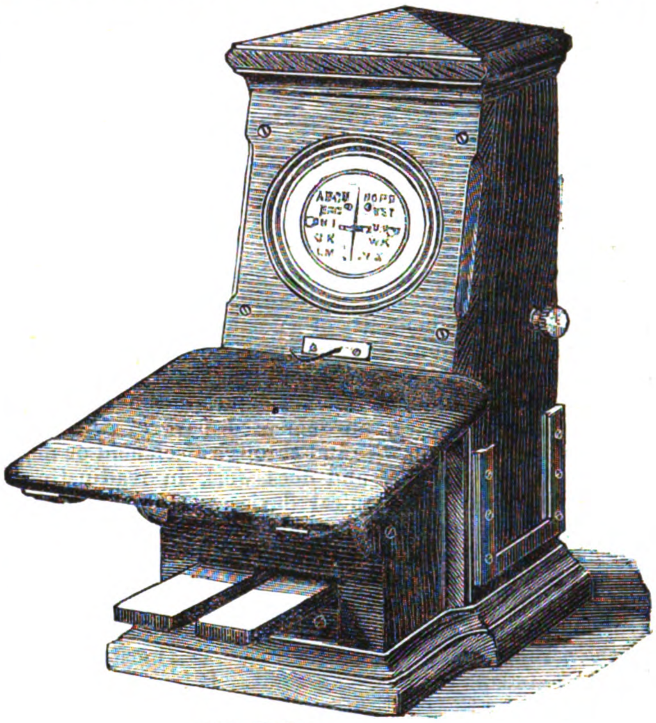


FIG. 6.—Wheatstone's A B C Telegraph Instrument.

single current sounder, double-current sounder, duplex double-current sounder set, Wheatstone's automatic system, Kempe's water level indicator, Professor Hughes's induction balance, and a pneumatic system. These signalling instruments comprise visual, recording, or non-recording, and acoustic systems. Galvanic batteries supply the requisite electric force for all except the Wheatstone A B C, which has a magneto-electric generator. Here the sending operator turns a handle continuously, and rotates a piece of soft iron in front of and close to the poles of a strong horseshoe magnet, the arms of which are surrounded by fine copper wire covered with silk. The moving iron disturbs the normal condition of the magnetic field, and develops thereby electrical currents in the copper wire coils. These currents change their course through the wire alternately as the iron armature revolves. The alternate electro-magnetic effects in the receiving instrument propel a small tooth wheel fitted on the opposite end of an axis to that which bears a pointer in front of a dial bearing letters, figures, &c. The dial has 30 divisions, hence that number of currents is required for a full turn of the pointer. Four pulsations would cause the pointer to indicate D, ten J, and so on. A similar dial on the *sending* instrument, with keys for depression behind the letters, regulates and controls the outgoing currents. The instruments are so easy to manipulate that no special training is needed to send and receive a message slowly, hence they render good service in private firms and small post offices where skilled manipulators cannot be obtained. Other telegraphic instruments necessitate long experience before a thorough mastery of their use can be acquired. Indeed, when we state that from the central station at St. Martin's-le-Grand, *fifty thousand* ordinary telegrams are sent and received *daily*, besides *half a million* or more of Press words every night, it will be understood that a professional telegraph clerk has much to learn before he or she can attain dexterity of manipulation sufficient for the requirements of an important office. Every class of instrument has its particular sphere of usefulness, and the system employed upon any telegraph line depends upon the nature of the work to be done, the amount of business, the number of places to be united on one wire, the length, construction, and state of the telegraph line.

The single needle is most used when several localities com-

FIG. 7.—An ordinary Single Needle Instrument complete, for reading by sight.



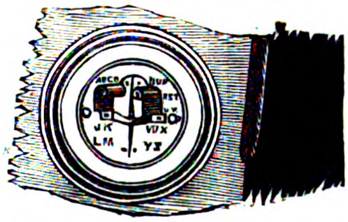


FIG. 7A.—A dial of the same, with resonant stops affixed, for reading by sound.

bined provide no more telegrams than suffice for one wire during office hours without causing delay. The Wheatstone automatic is invaluable for the despatch of newspaper intelligence, or a rush of work, as for example on the last Oaks day, when 57,441 messages (including 31,846 re-transmitted telegrams) were sent away from the Central Telegraph Station in London.

A brief description of the electrical principles of the systems of telegraphy above mentioned may not be unwelcome to some of our readers, and we therefore offer them a few simple explanatory remarks. Let us at the onset realise one fact, namely, that it is impossible to obtain electricity without an expenditure of energy. In the Wheatstone A B C no electricity would be developed unless the soft iron armature was made to revolve; the work done by the operator in turning the handle, or, in other words, the human energy expended, is, in fact, transformed into electrical energy. In the

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galvanic battery we have chemical energy converted into electrical energy. Now, if we joined the poles of a battery together with a wire, we should cause a current of electricty to circulate through the battery and wire; we should establish an unbroken path, or what is called in telegraphy a *circuit*. Bend the wire into a ring over a sensitive mariner's compass, and the needle moves to one side. Change the bend of the wire relative to the poles of the battery, and instantly we find the deflection of the needle reverse of what it was before. Why? Because the *direction* of the current round the needle is altered. This is the basis of the Needle instrument (Fig. 7). A horizontal axis supports two needles, one a magnet, inside, encircled by coils of insulated fine copper wire, and the other merely an index needle outside to show the movements of the magnetic needle as it is influenced by the currents of electricity passing through the surrounding wire. Instead of twisting the battery wire as before, a mechanical arrangement consisting of two pedals (or a drop-handle) varies the direction of the current, and thus produces single or combined beats of the index needle against the ivory pegs (Fig. 7) or tin cylinders (Fig. 7A) forming the telegraph alphabet. When the tin cylinders are employed the receiving clerk can either read by sight or by sound—the latter is the quickest and best.

(TO BE CONTINUED.)

THE ANDRE ARC LAMP FOR STREET LIGHTING.

In most arc lamps the distance between the points of the positive and negative carbons is adjusted, from time to time, through the instrumentality of a portion of the main current passing along a shunt wire, the resistance of which is high compared with that of the arc and the main circuit. When the arc grows long, and the resistance in the main circuit consequently increases, an increased part of the current passes along the shunt wire and through a solenoid or magnet in some form or other, and does work in readjusting the carbons by some mechanical device. However well the lamp may be designed, it is evident that its whole success depends on the sensitiveness of the shunt current acting on the regulating apparatus. If the length of arc is not constantly readjusted, not to a fixed length, but to a length depending on the varying condition or position of the ends of the carbons at the time, the result is a most unpleasant hissing sound or a flickering light. It is, according to M. André, because the performance of actual work by the shunt current absorbs so much of its sensitiveness that this method of employing it appears to be defective. The shunt current is only a small part of the main current, and therefore incapable of exercising any great power upon the regulator, which is therefore a somewhat delicate machine.

In the André street lamp it has been attempted to greatly reduce if not altogether to do away with these defects in the regulating apparatus. The shunt current acts on a very sensitive apparatus, and has scarcely any mechanical work to do; it does little more than determine the time when the feed train is to be put in motion. This feed train is actuated by a larger current, capable of overcoming any small obstacles, and supplied at definite short intervals.

The shunt current passes round the magnets of the regulator, and when, owing to the increase in this current, these magnets become sufficiently powerful, a swinging armature is attracted very near to the poles, but so as not to come in actual contact with either of them. As this armature swings round it switches the feed current, which is supplied intermittently through a separate wire, into the feed magnets, so that, before passing on to the next lamp, this comparatively powerful current works the feed train and readjusts the carbons. This armature is balanced by a small adjustable counter-balance weight, so that its action always corresponds with a definite strength of shunt current, and consequently with a definite condition of the arc as regards length or resistance. When the feed current is not made to pass through the lamp by this regulator, it is practically passed on to the next lamp in the circuit, so that this apparatus is really an automatic switch, which determines whether the feed current, in its passage through each lamp, shall be utilised to work the feed magnets, or shall be sent on without doing any work to render assistance to some other lamp. The motive power of the feed apparatus is obtained from an electro-magnet, which by means of an armature drives a train consisting of a ratchet and ratchet wheel, a pinion, and a vertical rack in connection with the positive carbon. This arrangement of ratchet wheel, pinion, and rack admits of very small movements of the adjustable carbon, while the electro-magnet is so proportioned that only a small current is required to enable it to produce a very considerable force, capable of overcoming any unusual mechanical resistance in the feed mechanism within reasonable limits. The feed current in all cases, whether it is employed in feeding any particular lamp or not, passes through all the lamps on a circuit.

In this lamp, as in other systems, the carbons are in contact at first starting. When the main current enters the lamp, the whole of it passes through an electro-magnet, which by means of an armature and intermediate gearing raises a tilting ring, and along with it the upper or negative carbon. This carbon, being much shorter and lighter than the positive carbon, and the whole main current being the motive power, the action of this arc striker is very certain, and the negative carbon is kept in its raised position as long as the current continues to pass through the lamp. One other special feature about these lamps requires notice. They have hitherto been constructed to burn positive carbons of one metre in length. In order to avoid the excessive resistance that would ensue if the current had to pass through a very great length of carbon, roller contacts are introduced near the points of the longer or positive carbon through which the current reaches the arc with very small resistance. The low resistance of these lamps, very little in excess of that due to the arc, is to a great extent the result of the arrangement just described. By the use of these roller contacts, at an approximately constant distance from the arc, a practically constant resistance is offered to the passage of the current. A current of twelve amperes has been found to give satisfactory results with these lamps, and ten of them, at least, in series can be supplied by one H Gramme generator.

The following description and diagrams will enable our readers to fully understand the mechanism and arrangement of this lamp:—Figs. 1 and 1A show views of the top part of the lamp. On the base plate A, which is insulated from the lantern by ring B, is mounted a standard, C. On the same base is fixed a two-armed electro-magnet, D, each coil consisting of four layers of No. 12 insulated copper wire wound on a wrought iron core, $\frac{5}{8}$in. diameter and $2\frac{1}{2}$in. long. The resistance of the whole magnet amounts to about 0·06 ohms. An armature, E, is suspended over the poles of this magnet by means of a rod, the other end of which acts on a lever, F, pivoted on the upper end of the standard C. This lever F is attached by two straps to a tilting ring, G, which is thus lifted whenever the armature E is attracted to the poles of the magnet D. Through this ring slides a rod, H, the lower end of which forms the holder for the negative carbon. Through the centre of the baseplate A, but insulated from it, rises the upper part of a long brass tube, J, which contains the positive carbon, the carbon itself being held central by means of roller contacts K (Figs. 2 and 3). The action of this part of the lamp begins as soon as the main current is turned on. The points of the carbons being in contact, the current enters through the positive carbon-holder, and after passing through both carbons is communicated through the standard C to the magnet D, the armature E is attracted, the ring G is raised, carrying with it the negative carbon-holder H, and so the arc is struck. When the current is turned off the armature is released, the carbon-holder H slides through the ring G, and the negative carbon falls into contact with the positive carbon, ready for another start. The brass tube J (Fig. 3), the upper part of which rises through the baseplate A of the upper part of the lamp, is continued downwards till it reaches a box cover containing the feed apparatus and the regulator. The feed apparatus

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(Figs. 4 and 5), consists of two A frames supporting a shaft, M, to which are fastened a ratchet wheel, N, and a pinion, O. In front of the two frames stands a pair of electro-magnets P, joined at the bottom by a breach-piece. Each coil consists of sixteen layers of No. 24 insulated copper wire, wound on a wrought iron core ½-inch diameter and 2 inches long, ture Q carries on its upper surface the ratchet S, gearing into the ratchet wheel N, and so drives the shaft M. The pinion O drives the long rack T, the top of which receives the lower end of the positive carbon, whilst the lower end is protected by a brass tube, U, fixed to the baseplate of the whole arrangement. A paul, W, prevents the ratchet wheel

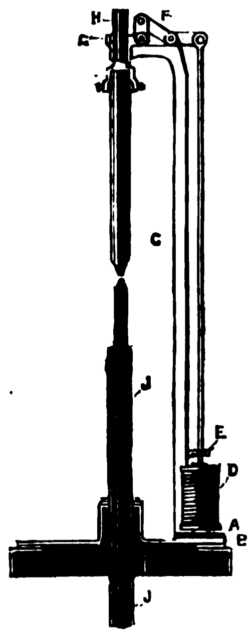


Fig. 1.—Showing Top Part of Lamp.

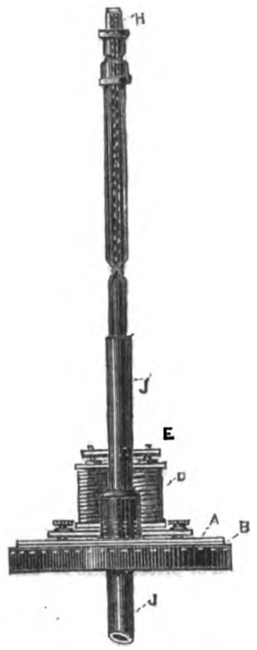


Fig. 1a.—Showig Top Part of Lamp.

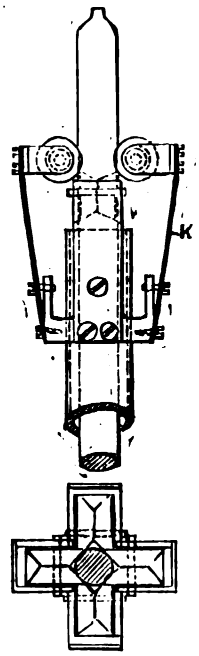


Fig. 2.—Showing Contact Rollers.

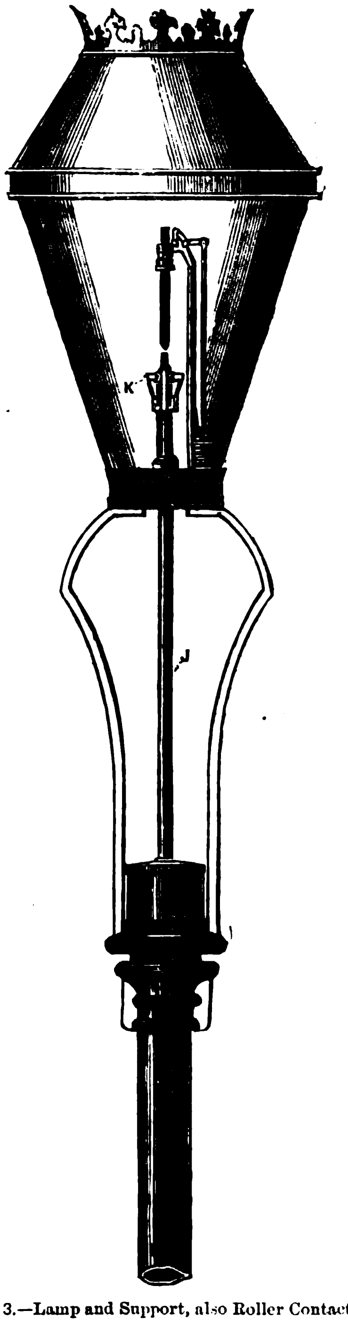
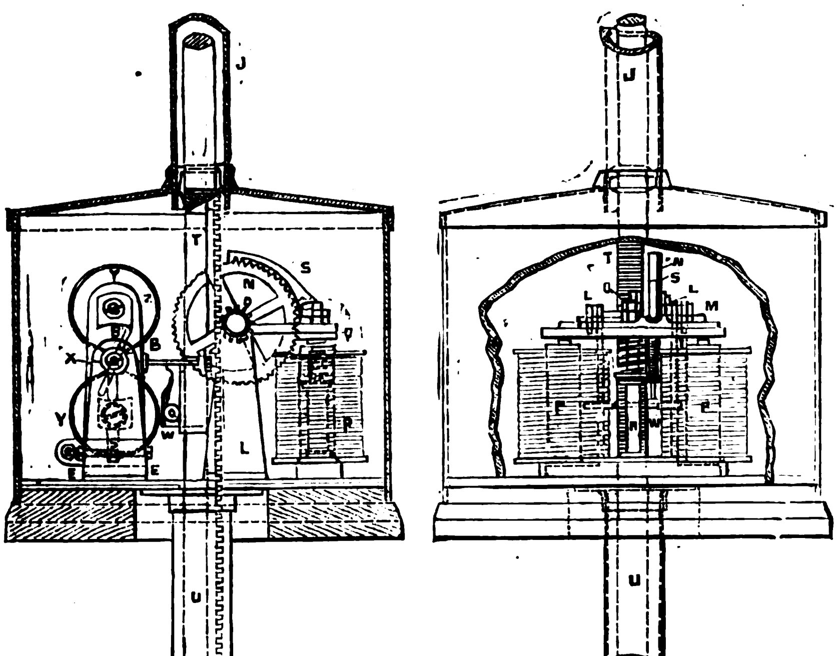


Fig. 3.—Lamp and Support, also Roller Contacts.



Figs. 4 & 5.—Showing Side and Front Elevations of Regulator and Feed Apparatus.

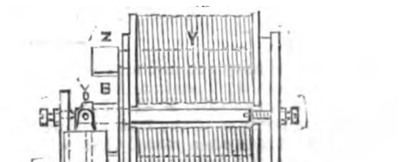


Fig. 6.—Showing Front Elevation of Regulator.

and the resistance of the pair of coils in series is about 6 ohms. At the ends of the shaft M, and outside the frames L, are two arms working loosely on the shaft, and carrying with their free ends the armature Q, which is adjusted to its proper position by the spring on the pillar R. The armature from running backwards. The ends of the feed magnet coils P are connected to the regulator, which is described below.

The regulator (Figs. 4 to 6) consists of a channel-shaped brass frame, X, between the arms of which are fixed two coils,

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Y, each containing 500 ohms of insulated copper wire, six mils. diameter, wound on a wrought iron core 5-16in. diameter and $2\frac{1}{8}$in. long, joined at the back end by a breech piece. The other end of each core passes through the front end of the frame X, and terminates in a pole-piece, Z, the inner surface being cylindrical, and described about the central axis of the pair of magnets. An armature, β, rigidly connected to a lever, γ, is pivoted about this same central axis, and is free to swing near the top pole-piece Z, which it never can touch, owing to their cylindrical shape. The lower end of the lever γ carries two platinum pins, δ and δ', which play between the ends of two screws, ϵ and ϵ', fixed to the frame X, but insulated from it, one of which is pointed with platinum, the other with an insulating material. The lever γ also carries a rod and an adjustable weight, by means of which any desired counterbalance can be given to the attraction between the magnets and the armature. The coils ζ are on a shunt from the main circuit. When the arc offers its proper resistance, the small amount of current passing through the shunt is insufficient to attract the armature γ in opposition to the resistance of the counterbalance weight ζ; but when the resistance of the arc increases, the proportion of current in the coils γ also increases, and the armature β is attracted. The feed current enters at the platinum pointed screw ϵ, whence a route, offering six ohms resistance, is always open to it through the feed magnets or to the next lamp. When the attraction of the magnets overcomes the momentum of the counterbalance weight ζ, the platinum pin β falls against screw ϵ', whose point is insulated, and the feed current has no other course except through the feed magnets. When, however, the weight ζ renders the attraction of the magnets upon the armature inoperative, the platinum pin δ rests against the platinum point screw ϵ, thereby opening a passage almost without resistance through the frame X on to the next lamp.

It is claimed as an important feature in these lamps that the feed circuit in no way robs the main circuit. It is taken off as a branch direct from the generating machine, and it is evident that the two circuits can be so proportioned that the momentary decrease of resistance to the passage of the total current, due to the throwing in of the feed circuit as an additional channel, shall cause an additional quantity of current to be generated in the machine exactly equivalent to that which passes along the feed circuit. Thus the intensity of the current in the main circuit is left unimpaired and constant.

The following, M. André states, are some of the principal features of the lamp:—

Current used	12 amperes.
Diameter of positive carbon	12 millimetres.
Diameter of negative carbon	18 millimetres.
Resistance of lamp when cold	0·1 ohm.
Resistance of lamp when lighted	2·0 ohms.
Resistance of arc	1·9 ohm.

Candle power (actual), about 1,000 candles.

BRUSH MIDLAND ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on the 16th instant, at the City Terminus Hotel, Mr. James Whitehead presiding.

The SECRETARY (Mr. H. N. Myers) read the notice convening the meeting and the minutes of the last meeting, which were confirmed.

The CHAIRMAN then stated that both of the meetings to be held on the occasion were of a formal character, the first being for the confirmation, or otherwise, of the resolutions passed at the last meeting. As he stated on that occasion, the alterations required to be made in their Articles of Association were required by the committee of the London Stock Exchange. They in no way adversely affected the value of their property—on the contrary, as they would facilitate their obtaining a settlement and quotation on the Stock Exchange, he was inclined to think, as their shares would then be more easily disposable, that the alterations would somewhat benefit their property. The directors and the solicitor quite concurred in the alterations.

The resolutions, which have been published in *The Electrician*, having been confirmed separately,

The CHAIRMAN said: The second meeting, as you are probably aware, is called to comply with the Act of Parliament, which is to the effect that a general meeting of the shareholders shall be held within four months of the allotment of the shares. The object of that, no doubt, is to give the directors an opportunity to state anything they may have to state as to the position of the company, and for any of the shareholders to make any inquiries they may think necessary as to the proceedings of the company during the time it has been in existence. I need hardly say that, having been in existence so short a time—only a few weeks—the whole of our time has been occupied in the organisation of your Company, I hope on such a basis as will lead to great success. While we have no doubt in our own minds with regard to the ultimate success of the Company, we cannot disguise from ourselves the fact that there are some difficulties—and I hope you will all realise that—to contend against in the establishment of a company, and especially of a company which is trying to introduce an entirely new system—I might almost say an entirely new principle. I may say, first, with regard to the work we have done, apart from organisation, that several overtures have been made to us with the view to our granting concessions; but while we shall be perfectly willing to grant concessions to sub-companies providing we can see our way clear to a fair and reasonable profit, we feel that there is an obligation imposed on us to see that those sub-companies are started in such a way as neither to discredit us nor be a failure in themselves. Seeing that we shall have an interest in the profits of the sub-companies—because that is the system generally adopted—it is our duty to see that we do not part with your property till we are perfectly satisfied that the boards of direction of the sub-companies will commend themselves to us, and satisfy us that they are likely to carry out the object we have in view—the carrying out of the electric system in the districts belonging to us—and that they will be able to return a fair and reasonable and adequate profit to the shareholders. We might have parted with several districts belonging to us—some odd counties, some groups of counties—but finding the conditions we required with regard to the character of the boards of direction were not complied with, we have felt it incumbent, not only in our own interests, but in the interests of the Brush Company, to decline the overtures made to us. Before I part from this subject I may say that many of you, being commercial men, are, no doubt, aware that many companies have been wrecked simply because they have not had proper boards of direction for their guidance, and we have been particularly anxious in our dealings with this matter to take care that our "children," were not only instructed, but that they should also have a fair start in life. There is one other point on which I should like to say a word—in regard to the question of price. One of the great difficulties in the establishment of a new system such as this is to acquire a sufficient amount of business at starting to enable the company, looking at all its ramifications and expenses, to realise a profit. It was so in the case of gas. I am old enough to remember when, in my district, gas was 10s. or 12s. 6d. per 1,000 cubic feet. That was only because the quantity used was not large enough to enable the gas company to make a sufficient profit, and so it will be for some time with these companies till electricity, as a system, has got into more active operation; but I am persuaded, as are also my colleagues, that whether it be twelve months hence, or two years hence, the electric system will be the illuminating power of the country, and that, in all human probability, those companies that have been started, as we think ours has been, on a fair and reasonable basis, will not only be successful in giving the public the electric light, but successful also in giving the shareholders an adequate return for the money placed in our care. On that point I may say it is very evident that the public are already aware of the great value attaching to electricity as a lighting power; but although that is clearly established a great many of the public do not realise the other advantages which belong to the electrical system. You must not forget that not only will you obtain the best light, and your curtains, decorations, and pictures be in no way injured by the new light, but the health of your family and your own health, which are so greatly jeopardised by the existing system, will, we hope and believe, be very much improved by the system we are now introducing. We must admit that the vitiation of the air by gas is very serious, and by the introduction of the electric light we shall have purer air in all our dwellings. There is one charge against us—I mean the Brush offshoots—namely, that we have paid too high a price for our concessions. I should like entirely to contest that point, so far as we of the Midland Company are concerned. You are probably aware that the total amount we paid for our concession was £43,750 for fourteen counties. This sum gives an average of £3,000 per county, and reckoning 10 per cent. per annum in order to provide for the interest on that amount and for the sinking fund, in order that the amount we have paid for our concession may be liquidated at the time our patents expire, a charge of not more than £300 per annum has to be made against those counties. To me that is a very satisfactory fact, and when we consider that we have important counties, with large populations, such as Cheshire, Leicestershire, Nottinghamshire, and Lincolnshire, I think you will admit that the position of this Company, as far as regards the price paid for the concession, is not a disadvantageous one.

A SHAREHOLDER inquired how the £43,750 was paid.

The CHAIRMAN: Partly in cash, partly in shares, and that, therefore, improves our position. If it should unfortunately happen, as we do not anticipate, that there is no dividend, there is no claim against the estate so far as that is concerned.

A SHAREHOLDER asked the proportions of the cash and shares paid.

The CHAIRMAN: £18,000 in shares, and the remainder in cash. I say that if the electric light system has anything in it, if it is to be the illuminating power of the future, and if the Brush system is, as we believe it to be, the very best of all the arc lights, then the amount we have paid for our concession, whatever other companies may have done, is not only not exorbitant, but is a very fair one indeed. It will be acknowledged by you that there has been a great scare recently in connection with electric light shares on the Stock Exchange, and that scare has possibly been helped forward more or less with the view of improving the interests of certain gentlemen who have very largely speculated in electric light shares. One of the systems adopted with a view to lower the value of the shares in the market is to issue circulars implying doubts as to the validity of the patents. That may suit the "bears," but I presume it does not suit the interests of the shareholders assembled today. We have no doubt, as far as we are concerned, as to the validity of the patents we have bought on your behalf for the Midland district, and if

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we had any we are amply covered by a guarantee from the Brush Company, and being satisfied that we have valid patents to work upon, and being satisfied that we have the best of all the electrical systems, we hope, by energy, pluck, perseverance, and economy, perhaps assisted by what little judgment we may be able to bring to bear on your behalf, at no distant day to give you an adequate return on the capital you have confided to our care.

A SHAREHOLDER asked if there were no further payments to be made beyond the £43,750.

The CHAIRMAN: Nothing whatever. The £43,750 is the absolute total cost of the concessions. All profits made will be for the shareholders, except that portion that goes to the directors, who are to receive £1,000 a year. We only come in for additional remuneration when 10 per cent. has been paid to the shareholders. I think you will see at any rate that the shareholders are on the best possible footing. In answer to other questions, he added: We have granted no sub-concessions, because the conditions we have imposed, more particularly with regard to the character of the boards, have not been come up to. In answer to a shareholder, the Chairman said: Before our concessions were granted to us, Mr. Hammond had acquired certain rights, and had obtained permission from the Brush Company to install any lights he liked, at his own risk, in any part of the country. He has acted on that permission, but immediately this Company comes into operation Mr. Hammond's rights in our districts cease, and he has no claim on us in any shape or form. We are entitled by our agreement with the Brush Company to have the benefit of all further improvements that may be made by them.

On the motion of Mr. MARTIN, a vote of thanks was passed to the chairman and directors. In reply,

The CHAIRMAN said: We are much obliged to you. I can assure you that my heart is in the cause, and if I fail, and my colleagues fail, you may rely on one thing—that it will be because circumstances have beaten us, and circumstances only. I may mention that, although we have been in existence so short a time, we have successfully lighted up the Boston Docks and the Market Hall of Chester, and that our system is already in very active operation in Nottingham.

The proceedings then terminated.

SOUTH AFRICAN BRUSH ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary meeting of this Company was held at the City Terminus Hotel, on the 19th inst., under the presidency of Lieut.-Colonel George Coxon, to consider a resolution substituting for Article 71 of the Company's Articles of Association another clause similarly numbered. The article as altered defined the circumstances which would render necessary the vacating of the office of director, and set out certain conditions which would have to be complied with in case of any director being concerned in the profits of any contract or transaction with the Company.

The SECRETARY (Mr. Thomas J. Seel) having read the notice convening the meeting,

The CHAIRMAN stated that it had been convened solely for the purpose of complying with the requisition and instructions of the committee of the Stock Exchange with regard to altering the article referred to. He moved a resolution for authorising the alteration.

Mr. I. S. GORDON seconded the motion, which was carried.

The CHAIRMAN stated that he had nothing to tell them concerning their affairs on the present occasion. The meeting for confirming the resolution would be held in about fourteen days, and on that occasion they would hold their statutory meeting also. He expressed his readiness to give any information which might be asked for. Replying to questions, he added that the Company had been started on the basis of a concession of Messrs. Blaine and Macdonald for the Brush patents for the Cape of Good Hope, and the purchase made of them was for the concession and the whole of the plant, &c., which the firm had acquired. Mr. Atkinson, one of the members of the board, was a partner of Messrs. Blaine and Macdonald, but he did not join the board until the purchase had been completed. They were, by the alteration which had been proposed in the 71st of their Articles of Association, removing the one object which had been raised against their having a quotation. They would not be able to obtain a quotation until the resolution had been confirmed, nor could he say how soon it would be afterwards before a quotation would be granted.

Mr. SHORROCK asked how the contract stood with the Kimberley Corporation.

The CHAIRMAN, in reply, stated that on the 11th of May last, which was the day, or the day before, the Company was formed, Messrs. Blaine and Macdonald received a telegram from Mr. Donald Macdonald, their managing agent, to the following effect:—"Have made a contract for Kimberley." It appeared that some difficulties had been raised there. He (the chairman) believed that there was a great deal of opposition when the matter came to be submitted to the ratepayers, and at the time the telegram was received the agitation was going on. No doubt they had heard, as had been rumoured, that money had been subscribed in Kimberley to raise an opposition and to take legal measures to test the validity of the poll of the ratepayers, which took place subsequently, on the subject of lighting the town, and in which the question of lighting was carried by a majority of twenty-one. He was, however, happy to tell them that about ten days ago—or three weeks subsequent to the time the report was spread about that the matter was to be opposed—they received a telegram again from Mr. Macdonald asking them to wire out an authority for the Kimberley agent of Messrs. Blaine and Macdonald to sign in the name of the Company the contract with the mayor. They might, therefore, take it for granted that the contract entered into between the Mayor of Kimberley, representing the corporation of the place, and the South African Brush Company had been signed, and that the Company was now in the position of holding the contract for lighting Kimberley for two years. There could be no question about it. They had received no information that there had been any hitch, nor could he see any reason for there being any. On receipt of this telegram they sent out (they had been already shipped) two machines, one a 16-light machine for Kimberley (making with the one previously there thirty-two lights), and another similar machine for disposal by their manager in any way he thought proper, as they had thought it advisable that he should have at hand, and for immediate use, plant and machinery for taking advantage of any opportunity which might open for extending the operations of the Company.

Mr. SHORROCK inquired the terms which had been arranged for lighting the town of Kimberley.

Mr. ATKINSON stated that some time ago the agent submitted terms to the Kimberley Corporation. These terms were afterwards taken into consideration, and were submitted to a meeting, which was adjourned from time to time, but the final meeting took place on the 10th of May, and a telegram was received to the effect that the contract had been accepted, but nothing more. Whether the terms had been modified to some extent in the contract was unknown, and would be until they got the contract over.

A SHAREHOLDER asked whether it was not stated in the prospectus that a town at the Cape was lighted up.

Mr. ATKINSON replied in the affirmative. The town referred to was Kimberley, and it was lighted for weeks before, but a contract had not been accepted.

The SHAREHOLDER thought that the statement was misleading.

The CHAIRMAN held that it was not misleading. An arrangement had been made with the authorities at Kimberley to light the town. That was known for months before, and the town was lighted as an experiment, but on the 10th of May a contract was made.

Mr. ATKINSON, in reply to a further question, thought it would be unwise at a public meeting to mention the price of the contract. That would be the way to cause competition. The information might be obtained by the shareholders at the offices.

The CHAIRMAN observed that before long they would, he hoped, be able to give the fullest information as to the Company. On the day the Company was formed they wired to Mr. Donald Macdonald to return home, and he was now returning, but until he arrived they could not give any conclusive information at such an early meeting as this in their history.

The proceedings then terminated with a vote of thanks to the chairman.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	Closing Prices June 21.		Business Done Week Ending June 21. Highest.	Lowest
Anglo-American	53,	54	53¾	52¾
Do. Preferred	83,	84	84¾	82
Do. Deferred	23,	24	23¼	22¼
Brazil Submarine	11½,	11¾	11¾	11½
Cuba	9¾,	10¼	10	10
Do. Preference	16,	17	—	—
Direct Spanish	6¼,	6¾	6 9-16	6 9-16
Do. Preference	15½,	16½	—	—
Direct United States Cable	11⅞,	12⅛	12¼	12
Eastern Telegraph	10⅛,	10⅜	10⅜	10¼
Do. 6 per Cent. Preference	13,	13½	—	—
Do. 5 per Cent. Debentures, 1899	102,	107	—	—
Eastern Extension	11⅝,	11⅞	11 11-16	11 7-16
German Union	9¾,	10¼	10¼	9¾
Globe Telegraph and Trust Company.	6⅜,	6⅝	6 9-16	6½
Do. Preference	12⅛,	12⅜	12 7-16	12⅛
Great Northern	12¾,	13¼	12¾	12¾
Indo-European	28,	29	29	29
Mediterranean Extension	2,	2½	—	—
Do. Preference	8½,	9	9	9
Reuter's	12¾,	13¼	13	13
Submarine	265,	275	269	269
West India and Panama	1¾,	2	1 15-16	1 15-16
Do. 1st Preference	8¼,	8¾	8¾	8½
Western Brazilian	7½	8	7¾	7½
West. Union 7 per Cent. 1st Mortgage	121,	126	—	—
Do. 6 per Cent. Sterling Bonds	102,	105	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1½,	1¾	1 15-16	1¾
Oriental	½,	¾	11-16	9-16
United Telephone	13¾,	14¼	14⅜	14

ELECTRIC LIGHT.

Electric Light and Power	¾,	1	1 1-16	¾
Anglo-American Brush	26½,	27½	29¼	25¾
Eastern Electric	4⅛,	4⅜	4¾	4⅛

TRAFFIC RECEIPTS FOR MAY, 1882.

COMPANIES.	May, 1882.	May, 1881.	Incrse.	Decrse.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	—	—	—	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	33,087	29,523	3,564	—
Eastern Telegraph Company	—	—	—	—
Great Northern Telegraph Company	21,720	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

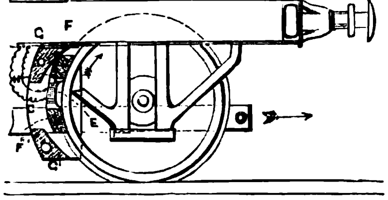
2807. Improvements in Telegraph Cables and other Conductors, *A. C. Ranyard, London, and J. A. Fleming, Cambridge.—27th June*, 1881.—(*Not proceeded with.*) 2*d*.

This consists in using manilla or other rope fibre in combination with "paraffine butter"—that is, a composition of paraffine mixed together at different boiling points, so as to render it always soft—as a covering for the wires of a cable

3464. An Electric Brake, *S. von Sawiczeski, Paris.—10th August*, 1881. 6*d*.

The figure represents the brake block in action. The electro-magnets E are enclosed in the box formed by the sheet iron C^1, suspended by spiral spring. The wedging of the brake blocks is produced against the wooden or metal pieces F F^1. Each electro-magnet has two brake blocks of special form, one upper and one lower, and are intended one for forward and the other for back-

3464



ward running. The action is as follows:—An electric generator in the train is connected by wires and commutators with the carriages and electro-magnets, so that the driver or guard may send a current acting on the electro-magnets, causing their instantaneous adhesion to the wheels, which then act as armatures. The impulsive force of the wheel carries the brake blocks in the form of wedges round into between the abutments G and G^1 and the wheel, which will cause a wedging action of a strength proportional to the current and the speed of the train.

3635. Improvements in the Production of the Electric Light, *T. Tubini, London.—20th August*, 1881.—(*Not proceeded with*). 2d.

The inventor makes the carbons of an arc lamp hollow, and causes gas or oil yielding carbonic atoms to pass through them, thereby augmenting the light, &c.

3932. Improvements in Dynamo and Magneto Electric Machines, *P. Jensen, London.—10th September*, 1881.—(*A communication from T. A. Edison, Menlo Park, N.J.*) 6*d*.

This relates to improvements on patent No. 1240, dated March 21, 1881, which consists in the

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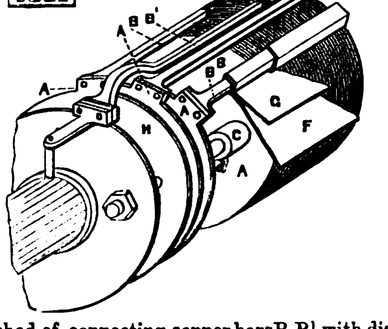
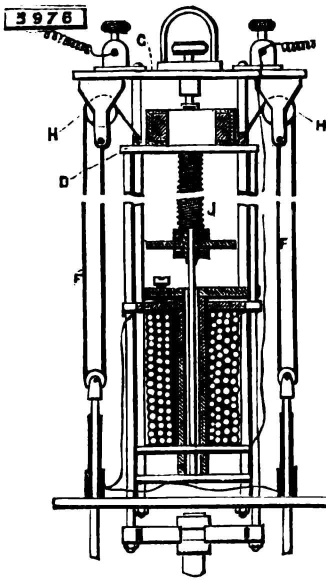


method of connecting copper bars B B^1 with discs by means of ears, A. The ears being now widened so as to close up the spaces between them. Bars B also extend straight to ears A, whilst B^1 are curved over the first line of ears to ears H of the second line. The contacts between the ears and the bars are plated with gold and silver. For commutator connections, rods having nearly the same conducting area as the bars are used; these contacts are also plated. To place the copper discs outside the field of force, the thimbles C separate them from the core as shown. The copper discs have double bevelled edges, forming angular spaces into which the projecting edges of the paper sheets used to insulate the copper discs are pressed to prevent electrical creeping between their edges. The copper bars are insulated by F parchment paper and G mica. An apparatus for driving a constant current of air through the armature is also described.

3976. Improvements in Elecric Arc Lamps, *P. Jensen, London.—14th September*, 1881.—(*A communication from A. J. B. Cance, Paris.*) 6*d*.

This is a continuous current lamp, though it can be converted into one for alternate currents. The lower carbon is regulated by the pulleys and cords shown. One end of cord F is fastened to plate G, having a hook for suspending the lamp, and the other end passes round pulley H, fixed to the base plate, and is fixed to upper cross bar

3976



D, uniting side rods of upper carbon holder. Cross bar D forms a movable weight, and has a receptacle for shot. D constantly tends to descend, and thus causes screw J to turn, so that the lower carbon is pulled up by cords F, while the upper carbon, by the turning of screw J is made to descend. The electro-magnet and solenoid core shown are placed in the lamp circuit, and serve to start the arc and regulate it also.

3987. Secondary Batteries or Magazines of Electricity, *J. S. Sellon, Hatton-garden.—15th September*, 1881. 6*d*.

The claims are, first, the use of supports to carry the spongy lead or other material, composed of alloys of lead with antimony; secondly, the

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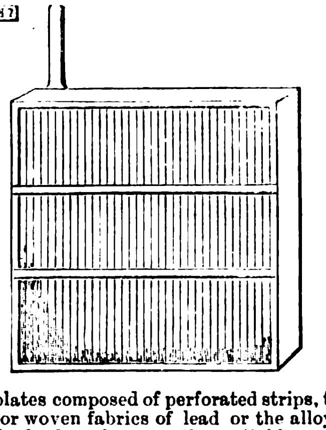


use of plates composed of perforated strips, tubes, pieces, or woven fabrics of lead or the alloy supported by lead, carbon, or other suitable material. One form is shown in the figure.

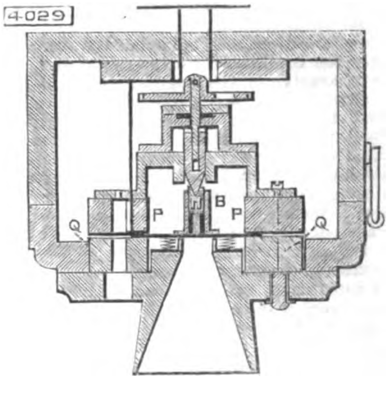
3519. Improvements in Means or Apparatus Employed in Lighting Gas by Electricity, *B. J. B. Mills, London.—13th August*, 1881.—(*A communication from L. A. W. Desruelles and G. J. A. Bourdoncle, Paris.*)—(*Not proceeded with.*) 2*d*.

The lighting of the gas is effected by a carrier of wood, in which is mounted a platinum coil heated to incandescence by an electric current. The carrier and coil are made to traverse the orifices of the gas burners.

4029. A New Construction of Telephone Transmitter, *S. Pitt, Sutton, Surrey.—19th September*, 1881.—(*A communication from H. Machalski, Lemberg, Austria.*) 6*d*.

This relates to a battery telephone in which graphite in a powdered state is used. The construction is as follows:—The vibrating plate is made of a thin sheet of iron or other similar metal, in the centre of which is attached by a gum a small tube B of elastic gum; within this is a second small tube, filled with pure pulverised graphite moderately compressed. The tube is closed by a metallic plug, the diameter of which

4029

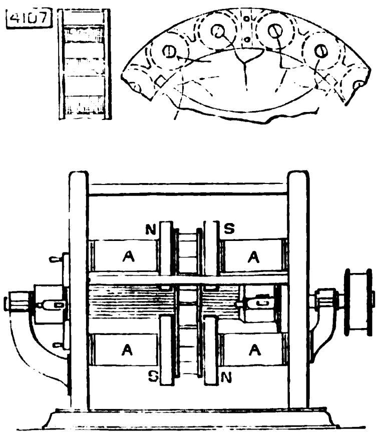


enlarges as it enters the tube, as its upper end is a conical hollow. Its base is also cylindrical, and contains a cylindrical cavity; upon this reduced end a small piece of elastic gum tube is applied, having the same height and exterior diameter equal to that of the plug. The plate with these accessories is placed between two rings P and Q. Between the plate and one of the rings a very thin conducting wire is placed, the other end of which goes to the holder. The figure will explain the arrangement of the apparatus.

4107. An Improved Dynamo-electric Machine, *F. E. Fahrig, Southampton.—23rd September*, 1881. 6*d*.

This relates to a continuous current machine, the coils of whose armature can be removed at will. Fig. 1 is a side elevation. The magnetic field is composed of magnets A. To the poles of each two upper and two lower magnets are attached by means of countersunk screws received in holes tapped in the cores, heavy semicircular

4107



pole pieces, N S S N, of malleable cast iron, which letters indicate their polarity. The armature, Fig. 2, consists of a number of transverse coils arranged round and parallel to the shaft, these being held in holes in pairs of segment-shaped plates, of which the annular frame of armature is built up. The coils are connected by wires each with a metal strip of the collectors.

2930. Improvements in Electric Lamps, *E. P. Ward.—5th July*, 1881. 2*d*.

This relates to incandescent lamps. The inventor substitutes iron or steel wires for the ordinary platinum connections with the carbon by enclosing each wire in an envelope of glass; the two envelopes thus formed are then connected by fusion at a suitable distance from the end. They are then united to the glass stem of the bulb by fusion.

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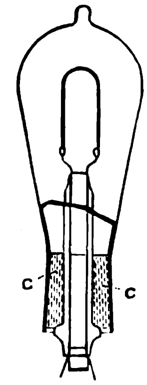
2833. Improvements in Incandescent Lamps, &c., *G. G. André, Dorking, and E. Easton, Westminster.—28th June,* 1881.—*(Not proceeded with.)* 2*d.*

The inventors use vegetable substances, such as rushes, grass stems, &c., for the carbons, and stretch them between two metallic conductors in a straight line, instead of the curved or horseshoe form usually adopted.

4174. Improveents in Electric Lamps and the Manufacture thereof, *E. G. Brewer, London.—27th September,* 1881.—*(A communication from T. A. Edison, Menlo Park, New Jersey, U.S.)* 8*d.*

Part of this invention refers to a cheaper method of providing the neck of incandescent lamps with the collar for attaching the lamp to its socket support. This is done by dropping the metal rings of the collar into a mould, wires being first soldered to the inner surface of such rings, which are arranged to project upwards on opposite sides of the mould. The wires of the lamp are bent up in opposite sides of its neck, and the lamp is dropped into the centre of the mould and held upright there. The wire ends of lamp and

4174

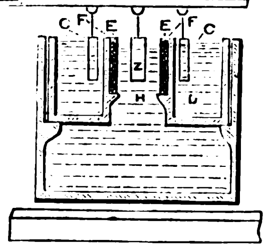


collar rings are twisted together and turned down into the mould, which is then filled with plaster of Paris and allowed to harden. Another portion of the invention refers to the construction of a lamp which can be taken to pieces when the carbon is destroyed, and all parts used again, except the carbon. The figure shows such a lamp. The glass globe is made to taper out at bottom. C is a tapering rubber stopper which has a tendency to be pressed into the globe by the atmospheric pressure, and which therefore holds the wire support tight. The methods adopted for electroplating the union of the carbon and wires are also described with other improvements.

4309. Improvements in Galvanic or Electric Batteries, *F. Wirth, Franfort-on-the-Main.—4th October,* 1881.—*(A communication from Dr. J. Stebbins, New York.)* 6*d.*

The object of the invention is to produce a battery of great constancy and easy regulation. The form thereof is shown in the figure. The bottom of H forms a non-porous reservoir. E E are porous walls of the upper compartments; F F

4309



non-porous material which can be adjusted to permit as much action as required to take place through E E. The letters D D represent non-porous cups, through the bottom of which is an opening Z to represent the zinc plate in dilute sulphuric acid, C C being carbon plates in a solution of bichromate of potassium.

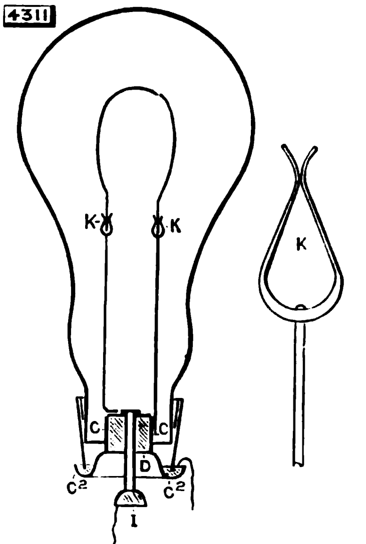
2823. Secondary Batteries, *A. P. Laurie, Edinburgh.—28th June,* 1881.—*(Not proceeded with).* 2*d.*

This relates to the use of zinc and carbon electrodes in a solution of iodide of zinc.

4311. Improvements in Electric Lamps, *J. H. Johnson.—4th October,* 1881.—*(A communication from C. A. Faure, Paris.)* 6*d.*

This relates to incandescent lamps. The inventor fixes a metallic socket to the stem of the glass globe, by fusing said stem to the inside of the socket, or by electro-plating the stem, then turning the socket and soldering the latter on to the electro-plated deposit. The carbon holder consists of a metal tube, C, closed by glass plug, D, the tube being splayed out into trough C^2, so

4311



as to contain a metal which fuses at a low temperature, to receive the outer edge of the socket so as to make an air-tight joint, the object being to enable the carbon holder and the carbon to be withdrawn by simply fusing the metal so as to unsolder the parts. The carbon holder C and socket form one conductor, and tube I forms the other. The carbon is secured between two spring clips, K, of platinum. The inventor makes his carbons of thin strips of graphite or carbon, which are heated and bent to shape required.

255,137. Armature for Dynamo-Electric Machines, *George H. Brown, New York, N.Y., assignor to Charles A. Cheever, same place.—Filed November 14th,* 1881.

Brief.—The core of the armature has a section cut out, leaving a space, through which the separately-wound bobbins may be slipped to place

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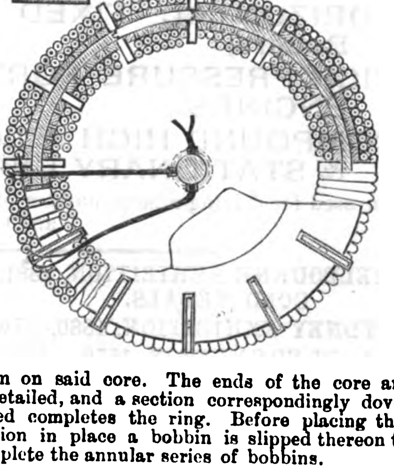

them on said core. The ends of the core are dovetailed, and a section correspondingly dovetailed completes the ring. Before placing this section in place a bobbin is slipped thereon to complete the annular series of bobbins.

4420. Improvements Relating to Telephone atd Telegraphic Apparatus and Circuits, *S. Pitt, Sutton.—11th October,* 1881.—*(A communication from W. R. Patterson and C. E. Scribner, Chicago, U.S.A.)* 6*d.*

Part of this invention refers to an improvement whereby a central office manager can regulate at will the number of subscribers to be taken care of by a single attendant, and also a method of notifying the latter of a call when he is not listening at his telephone. By this invention the subscribers' wires are grouped at the central office to a common wire which connects to a listening operator's telephone and thence to ground, and the terminals of subscribers' individual wires are connected through call bells at subscribers' offices, and thence to a common wire, the said wire serving to group the outer ends of the telephone wires together. Each subscriber is thus provided with two circuits—first, his individual telephone; second, the lines of his group that happen to be connected with the common line at their outer ends when he connects with the said common line. Another improvement consists in connecting the calling battery with a point near the lever of each spring jack, and so constructing the plug that the switchman may by means of it connect any subscribers' line with a contact point connecting with the calling battery, and thus signal the subscriber. The invention also refers to improvements in telephone cables, whereby induction is neutralised.

255,885. Thermo-electric Battery, *Andrew Patterson, Idelwood, Pa.—Filed January 9th,* 1882.

Claim.—(1). The combination of the members of a thermo-electric couple with a mass of refractory insulating materials in which they are em-

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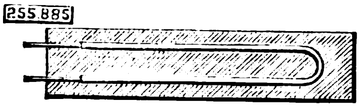
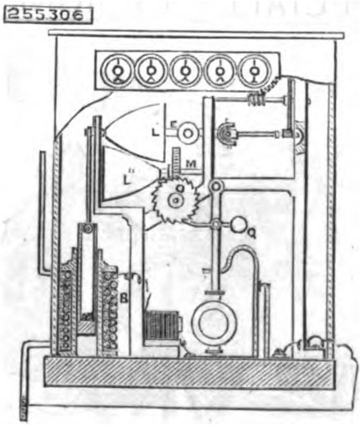


bedded, whereby fusible or oxidable materials may be used for the couple without injury from fusion or oxidation, substantially as described and set forth.

255,306. Electric Meter, *Hiram S. Maxim, Brooklyn, assignor to the United States Electric Lighting Compang, New York, N.Y.—Filed July 20th,* 1881.

Claim.—(1) In an electric meter the combination with the axially-movable core of the magnet B, of the universally-jointed shaft E, connected thereto by an intermediate link, and almost connected by intermediate gears with a registering apparatus, and carrying the conoid L, arranged to rock longitudinally upon the conoid L'', mounted upon a shaft journalled in fixed bearings and rotated by armature mechanism, substantially as described. (2) In an electric meter, the combination, with a registering apparatus, of a conoid, L, mounted upon a universally-jointed shaft in gear with said registering apparatus, a conoid-L'', mounted upon a shaft rotating in fixed bear, ings and supporting the first-named conoid upon

255306



its surface, suitable devices for varying the point of contact between said conoids by the influence of an electric current over the main line, and automatic mechanism for rotating said conoid L'' under the influence of a current derived from said main line, substantially as described. (3) The combination, with the registering apparatus and the electro-magnet B, arranged for connection with a main line, and provided with an axially-movable armature, of the universally-jointed oscillating shaft E, in connection with said apparatus and carrying the conoid L, a link connecting said shaft with said armature, the conoid L'', mounted upon shaft M, carrying a worm wheel, the ratchet wheel O, fixed upon a shaft carrying a worm meshing with said wheel, an electro-magnet in a circuit derived from the main line, a pendulum adapted to be oscillated thereby and provided with a pawl, Q, substantially as described,

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THE EXCHANGE TELEGRAPH COMPANY, LIMITED.

Head Offices—17 & 18, Cornhill, E.C.; Stock Exchange, E.C.; 27, Regent Street, W.

Incorporated the 28th March, 1872, under the Companies Acts of 1862 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

Not having any springs or clockwork to wind up or to depend on, these instruments are acknowledged by those familiar with the system of telegraphy to be the only instruments yet invented that are capable of doing the work required of them continuously for a lengthened period, as evidenced by the fact that the Gold and Stock Company of New York, having the monopoly of this kind of business in the States, and which owns all the patents of the day of any value, has, after due trial, discarded all others.

The Company is prepared to treat with provincial Companies requiring instruments for the delivery of news for either single or double wire systems under the Company's patents, whereby from central stations identical information can be simultaneously delivered to any number of recipients by automatic, self-adjusting, printing instruments requiring no local batteries, no winding up, and no knowledge of telegraphy on the part of the receiver, the printing being in bold roman type, and the propulsion of the paper being effected by the electricity supplied from the Central Office.

The instruments supplied by the Company can be had to work either on single or double wires, and to print either on a slip or tape of paper, as has hitherto been the custom, or on a broad band of paper in column form.

The system has been in use by the Exchange Telegraph Company (Limited) in the City and West End of London since 1872, and by MacMahon's Telegraphic News Company (Limited), for the delivery of Parliamentary, Sporting, and General Intelligence, since 1879.

The Company will supply householders and others with its

DISTRICT CALL SYSTEM.

By the aid of a small automatic telegraph instrument a Subscriber can at any hour, day or night, call a messenger, cab, or policeman, or give the alarm of fire, and will obtain the required assistance within three minutes of making the signal. Subscribers, when absent from their homes for a season, can leave their houses closed, and have them taken charge of by the Company, and rendered perfectly secure against burglars by a telegraphic communication with the nearest District Call Station of the Company, where a policeman will always be in readiness day and night to respond to calls.

Provincial combinations to work under the Company's Patents will be treated liberally.

The Company is also prepared to supply Municipalities with its system of

STREET FIRE ALARMS

as recommended by H. M. Postal Telegraph Department to the Metropolitan Board of Works for the Metropolitan Fire Brigade, and which has received favourable mention by Captain Shaw in his last annual report.

These Alarms have recently been considerably improved by the Company, and are acknowledged to be the simplest yet constructed.

All communications to be addressed to the Secretary as above.

MARSHALL, SONS, & CO., LIMITED,

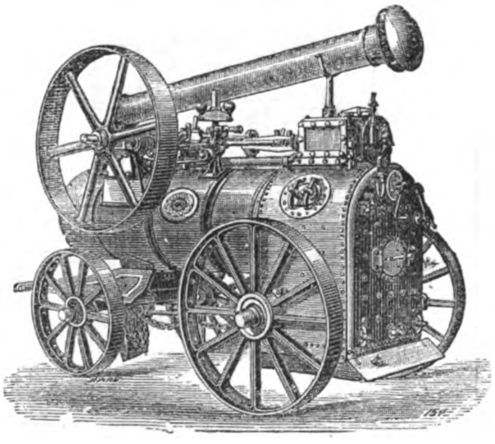
Britannia Iron Works, GAINSBOROUGH, & 3, King Street, Cheapside, LONDON, E.C.

MANUFACTURERS OF

STEAM ENGINES,

Fitted with Patent Automatic Expansion Valve Gear, and

SPECIALLY DESIGNED FOR DRIVING ELECTRIC LIGHT MACHINERY.



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HORIZONTAL FIXED ENGINES, with separate Boilers,

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COMPOUND HIGH & LOW PRESSURE PORTABLE & STATIONARY ENGINES,

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CONTRACTORS TO H.M. GOVERNMENT AND RAILWAY COMPANIES.

LONDON OFFICE: 72, KING WILLIAM STREET.

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SLIP

BARBADOES.—The sittings of the Telegraph Conference at Barbadoes have closed.

THE CHANNEL TUNNEL.—The electric lights are again in use in the Channel Tunnel Works.

THE CROOKES LAMP.—The Gülcher Electric Light and Power Company have acquired the incandescent lamp of Mr. William Crookes, F.R.S.

WORKING ON THE ATLANTIC CABLE.—The *Operator* states that the first Gould cable, laid in 1881 by Messrs. Siemens Brothers, has attained a working capacity of about seventeen and a half words per minute.

ELECTRIC LIGHT IN SYDNEY.—Recent news from New South Wales states that the South Australian Electric Company had imported the necessary machinery for five electric lights, and would shortly have them in operation in the city.

ANOTHER VOLTA PRIZE.—A fresh Volta prize of 50,000fr. has been created by the French Academy of Sciences for the most remarkable discovery in electricity during the next five years. The competition will close on the 31st of July, 1887.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The coupons due June 30 on the debentures of this company will be paid at the offices, 98, Cannon-street, London. They must be presented for examination three days before payment.

BRUSH MIDLAND ELECTRIC LIGHT AND POWER COMPANY.—We are requested to state that the directors of this company have decided not to make the call of £1 per share fixed for the 1st July, as sufficient capital is in hand for present requirements.

LONDON PLATINO BRAZILIAN TELEGRAPH COMPANY.—The revenue of this company for the month of March, 1882, is estimated at £2,559 (Western Brazilian portion £1,740, land lines £819), as against £2,514 for the corresponding period of 1881.

UNDERGROUND ELECTRIC LIGHT WIRES.—Professor E. J. Houston, of Philadelphia, has investigated the subject of underground wires for electric lighting, and has given his opinion that such a system is perfectly feasible, and certainly safer than overhead wires.

WESTERN BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended the 16th ult. amounted to £1,816, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half-month ended June 15 are £2,484, as compared with £2,713 in the corresponding period of 1881. The February receipts, estimated at £5,459, realised £5,632.

ELECTRIC LIGHT FOR HELL GATE.—We stated some time since that this dangerous entrance to New York Harbour was to be lighted by the electric light. It has been determined to have two groups of ten arc lamps of 2,000 candle-power each at either end of the passage.

TORNADO IN AMERICA.—A severe tornado passed through Missouri, Illinois, Kansas, and Iowa States recently, doing a great amount of damage, and, amongst other things, wrecking the telegraph lines and entirely interrupting communication in the district through which it passed.

COUPONS.—The Eastern and South African Telegraph Company state that the coupons due this day (July 1) on their Five per Cent. Mortgage Debentures will be paid on presentation by Messrs. Barclay, Bevan, and Co. Coupons must be left three clear days for examination.

THE TELEPHONE IN MINES.—An American contemporary says that the telephone refuses to work in the deep mines on the Comstock, Nevada. The magnets rust in a few hours, so nothing goes through. Some were tried in the Sutro Tunnel, inclosed in air-tight boxes, but they failed to operate.

THE EDISON LIGHT IN CAPE TOWN.—The *Cape Times* of May 13 says:—"The House of Assembly continues to be lighted by the electric light, and the result has so far been highly satisfactory. The light is full, clear, pervasive, and steady, and greatly improves the appearance of the Chamber."

ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS.—The annual meeting of this association was held from Thursday to to-day (Saturday), and took place at the Institution of Civil Engineers. Amongst other papers, Mr. W. Sugg read one on "Gas as An Illuminating Agent Compared with Electricity."

THE COST OF ELECTRICITY.—The cost of supplying electricity for lighting and other purposes to one square mile has been recently stated to be about as follows by the undermentioned authorities on the subject, viz.:—By Dr. Siemens, £400,000; by Dr. John Hopkinson, £200,000; and by Mr. Spottiswoode, £100,000.

PROPOSED ALTERATION OF THE MORSE ALPHABET.—It has been proposed by Mr. W. G. Stevens, in the New York, Pennsylvania, and Ohio Railway Company's telegraph service, to alter the present Morse signal for O or cipher to two dots and two dashes. It is stated that this alteration is likely to be adopted before long in America.

UNDERGROUND TELEGRAPHS IN FRANCE.—In the report of the Budget Committee on the French Posts and Telegraph Estimates for next year it is stated that the network of underground telegraph wires now being laid will cost when finished £2,120,000, of which more than half has already been spent. The system will be about 1,400 miles long.

TELEPHONIC CONCERTS.—Messrs. Tasker, Sons, and Co. gave a series of very successful telephonic concerts in Sheffield last week. The music of a military band was conveyed some miles by wire to large audiences in the Cutler's Hall. More than 200 telephones were brought into use, and the arrangements for the visitors were of the most complete description.

ELECTRICAL RAILWAYS.—A lecture on this subject was given in Trinity College, Dublin, on Monday last, by Dr. A. Traill, and not Dr. Siemens, as we stated in our last issue. The lecturer referred particularly to the electrical tramway now being constructed at Portrush, in the County of Antrim, and exhibited a model car, which was made to work in the lecture room.

BOILING WATER BY ELECTRICITY.—When giving evidence before the Select Committee on the Electric Lighting Bill, Dr. John Hopkinson stated his belief that the whole of the electricity generated by one horse-power would not do more than boil one and a half gallon of water an hour. This was to show that electricity is not likely to be used in the future for heating purposes.

ELECTRIC LIGHT IN BALTIMORE.—The Brush Company have at work ninety-six out of the two hundred and twenty-five electric lamps which they are to supply to the city of Baltimore. The lamps are fixed on poles, eighteen feet high,

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with swinging globes, the poles being placed from three to six hundred feet apart. We believe that the lights have given great satisfaction.

Telegraphic Delay.—Our contemporary the *Globe* remarks in its issue for the 24th June :—"Two hours and twenty-two minutes is rather a long time, considering the modern facilities, for a message to get from Westminster to the Strand. Yet this is the time a telegraphic message takes —at all events, took yesterday," and adds sarcastically, "one could almost walk the distance in the time."

Markland Electric Light Company.—This company announce that the shares offered to the public not having been fully subscribed the deposits paid on application will be returned at once without deduction. The company also announce that on the arrival of a large consignment of their lamps, which they have ordered from New York, a full installation of their system will be publicly made.

Central and South American Cable.—The India Rubber, Gutta Percha, and Telegraph Works Company have received a telegram from their engineer, Mr. Robert Kaye Gray, on board the steamship "Silvertown," announcing the laying, on the 21st inst., of the Buenaventura-Panama section of the Central and South American Telegraph Company's cable, by which that company's system is completed from Lima to Panama.

New Atlantic Cable Company.—An American contemporary says the American Atlantic Cable Company of New York has filed amended articles of incorporation. The general route of the line of telegraph is from New York City to a point convenient upon the coast of the United States, and thence to the coast of Portugal, Spain, or France in Europe. The capital is 10,000,000 dollars, which can be increased at the discretion of the stockholders.

Alexandria.—The *Standard* correspondent at Alexandria says:—To-day (Sunday, 25th June) I inspected the Eastern Telegraph Cable Company's organisation. It is admirable. They are prepared at a moment's notice to transfer their staff and instruments outside the harbour. Communication will not be interrupted for half an hour." It is stated that in case of emergency this company's offices will form the rendezvous for all the Europeans in the city.

New American Telegraph Company.—The Northern Mutual Telegraph and Telephone Company has been formed. The general route of the line is through the State of New York from east to west and from the city of Oswego eastward and westward. The points to be connected are the city of New York, and cities of Syracuse, Oswego, Ogdensburg, Buffalo, Elmira, Binghamton and Albany. The capital is 250,000 dollars, with the provision that it may be increased to 1,000,000 dollars.

Electric Light Wires and Chicago Firemen.—The decision of the mayor and chief magistrates of Chicago that electric light wires must be placed underground is said to have been greatly influenced by the representations of the firemen of that city. The men stated that their lives were placed in danger when the wires were run overhead, asserting that if a fire took place near the wires the insulation would be melted off and the wires thus rendered dangerous to any person coming in contact with them.

Electric Railway in Holland.—The first electric railway constructed in Holland was opened a few days since. It runs from the Bath at Zandvoort, near Amsterdam, to Kostuerloren, a small park in the neighbourhood. It is one kilometre and a half long. The line has been constructed on the system of Messrs. Siemens and Halske, of Berlin, the steam engine used being of 15 horse-power. The current is conducted along the rails and through the wheels to a dynamo under the car. The gauge of the railway is one metre.

Crystal Palace.—It is proposed by the Crystal Palace authorities to organise an exhibition in the coming autumn and winter, which shall include both gas and electric lighting. The exhibition is to be of an international character, and it is hoped that the latest improvements in both cases will be well represented. This is an excellent move and one in the right direction. We have no doubt that electric light engineers will enter heartily into the project, and do their best to show what their light can do in direct competition with gas.

The Sun Lamp.—This lamp, better known on the Continent as the Lampe-Soleil, was exhibited on Saturday last in the vaults of the Royal Exchange. Our readers will remember that we illustrated this lamp as in use at the Paris Opera House in a recent number. It is the invention of M. Clerc and M. Bureau, of Brussels. In this lamp two carbons impinge upon a block of marble, which latter becomes incandescent when the arc has been established, and gives the pleasant mellow light which has led to its being named the Sun lamp.

Electric Light at King's Lynn (Norfolk).—An introduction of the electric light has just been made into King's Lynn at Messrs. Walker's mill. This contract has been carried out most successfully by the British Electric Light Company (Limited) with the Gramme machine and sixty-two British incandescent lamps. Messrs. Walker believe that the lighting will cost much less than they have hitherto paid for gas. A Brockie arc lamp of 6,000 candle-power has also been suspended in the market place from a davit 47ft. above the street level, and throws a flood of brilliant light over the whole of the market place and the adjoining thoroughfare.

The Jablochkoff Light.—According to figures which have been afforded by Messrs. Samuel Brothers, of Ludgate Hill, the cost of the Jablochkoff lights there is only £150 per annum, the premises being lighted on an average three hours each night. There are 20 lights altogether, each giving 378 candle-power, equal to about 35 ordinary gas burners. These are driven by a 12 h-p. Otto gas engine. The cost is estimated as follows:—Jablochkoff candles, 1d. per hour for each lamp; gas consumed in Otto engine also 1d. per hour for each lamp—total 2d. Five of the above lights are employed outside the premises, the remainder light up a space of 4,000 square feet.

Underground Telegraph Wires at Pittsburgh.—A company formed to work a patent taken out by Mr. Worrell, a brass founder of Pittsburgh, U.S.A., for a new system of underground cables, have obtained leave from the Town Council to lay an experimental cable for testing purposes. The cable will be laid from Negley's Run to the centre of the city, a distance of seven miles. It is stated that the inventor constructs his cable of corrugated lead, one inch in diameter, perforated with five small holes, through which the wire is drawn. The composition of the insulating material is not known. According to the latest account, the laying of the cable had been begun.

Electric Lighting in Italy.—Sixty Edison incandescent lamps, A size, have been fitted up in the cotton mill of Signor Benigno Crespi, of Vaprio, and have worked satisfactorily for some time past. Messrs. Cavaliere and Franco, of Bologna, have also adopted these lamps in their flour mill, and are said to be very satisfied with them. Sixty A lamps

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are used in this case also. Arrangements are nearly completed for fixing 120 B lamps in the cotton mill of Cavaliere Andrea Ponti, of Solbiate Vlona, near Bristo. The whole of these installations have been carried out under the superintendence of Mr. James Shepherd, the very able and energetic representative of the Edison Company in Milan.

Electric Lighting in the City.—According to an abstract of the tenders recently sent in to the Commissioners of Sewers for lighting three new districts, and the district lately lighted by Messrs. Siemens Bros. in the city, the prices were very variable. The figures are for twelve months' supply of light, including fixing machinery, &c. The prices vary for district No. 1 from £2,190 to £5,750, the present cost of gas being £551; for district No. 2 the figures fluctuate between £2,350 and £4,270, the cost of gas being £363; for district No. 3 the prices vary from £2,470 to £3,800, cost of gas, £341; and in district No. 4 they go from £2,920 to £4,350, against £612 for gas.

Telephonic Sounds.—The *Operator* says: "Mr. Nat. G. Warth, manager of the Midland Telephone Company, at Gallipolis, O., writes: 'Please give some one the chance of explaining this phenomenon. This morning early, while in temporary communication over a Western Union wire with Major R. B. Hoover, at Pomeroy, Ohio, twenty miles away I could distinctly hear the croaking of frogs and the singing of birds. The wire passes through dense woods, and along large streams between the two points. There were only the two sets of instruments in circuit. The sounds certainly were taken up and transmitted from some point between us. Now, by what law could this occur? Could the sound have been induced by a damp atmosphere?'"

Post Office Telegraphs.—In the House of Commons on Thursday week Mr. A. Morley asked the Postmaster-General if it was proposed to apply to the Engineers' Department of the Post Office a scheme similar to that which was applied last year to the Commercial Department; and, in the event of its being so proposed, if he could state whether the scheme had yet been approved; how soon it was expected that it would be published; and whether it would date back to April in last year, as was the case with the scheme applied to the Commercial Department. Mr. Fawcett replied that the scheme was settled, and that instructions had already been given for putting it in force from the 1st of April, 1881. Mr. Stewart Macliver, M.P., has also received a letter from the Postmaster-General confirming this.

Electric Lighting Bill.—Mr. Barran has given notice that on the House going into committee on the Electric Lighting Bill he will move the insertion of the following clause in the Bill:—"Notice of application for Provisional Order.—No application for a Provisional Order on the part of any company or person shall be made in respect of all or any part of the district of a municipal or other local authority without nine months' notice in writing (which shall define the area intended to be comprised therein) to such authority, who shall within that period, but subject to the last-mentioned provision (Clause A), be entitled to make application for a Provisional Order in respect of all or any part (including the area defined in such notice) of such district; and, until such application has been disposed of, no other application shall be entertained."

Secondary Batteries.—Patents were taken out in America on the 14th and 28th October, 1879, by Professors Thompson and Houston for a storage battery. It is stated that the Brush Company and the American Company of New Britain are disposed to contest the Faure patent on the ground that it was anticipated by the above-mentioned patents. The first claim of the patent, dated October 14, is as follows:—"The combination in a cell for voltaic batteries of an enclosing vessel, two conducting plates (neither of which is electro-positive), one serving as a receiver for electro-positive metal and the other as a source of supply for the formation of an electro-negative resultant, and a solution in which said plates are immersed, said solution being incapable of generating electrical action until the passage through it of an electrical current," &c.

Precautions Against Fire.—The Anglo-American Brush Electric Light Corporation have decided that their premises in Mansfield-street, Borough, shall be provided with such means as will enable their *employés* to cope with any outbreak of fire which might occur, independently of outside assistance, and during the period which must necessarily elapse between the discovery of flames and the arrival of a fire engine. Messrs. Merryweather and Sons, of Long-acre and Greenwich, have been instructed to fix eight of their improved high pressure fire hydrants upon the premises, which will be constantly charged from two points of the water company's main, and each hydrant supplied with a full complement of leather fire hose and nozzles. The arrangement has been devised by Mr. J. H. Heathman, the author of "On the Preservation of Life and Property from Fire," under whose supervision the work will be carried out.

The Anglo-American v. Scotch Brush Company.—The petition of the Anglo-American Brush Electric Light Company praying that the affairs of the Scottish Brush Electric Light Company might be wound up was heard in the Court of Session, at Edinburgh, on the 22nd June. The Court decided that the petition was premature, and dimissed the case with costs against the petitioners. The question in dispute was whether an undue proportion of the shares in a new company, to be called the Brush Company of Scotland, floated by the Scottish company, had been illegally allotted to shareholders in the Scottish company, thereby depriving the Anglo Company of shares which should have come to them. The answer made by the Scottish company was that the time for issuing the remaining shares of their company was extended for six months from 31st December last, and that therefore the present petition was premature. Judgment was given as above mentioned.

Overtime in the Post Office.—In reply to a question asked by Mr. Stuart Wortley in the House of Commons on Monday last as to whether under Sec. 7 of the new scheme "it was intended that overtime work on Sundays should be in all cases separately accounted and paid for, and whether he approved of such a construction of that section as reckoned Sunday overtime work in substitution of time not worked out on any of the other six days of the week," Mr. Fawcett replied that a sorting clerk and telegraphist is liable for the performance of an average of two hours' duty on each Sunday, so that the attendance does not exceed eight hours in four consecutive Sundays, and a separate record is kept of this attendance. Including the two hours on Sunday he must perform fifty hours' work a week. He was not aware that this rule had been departed from in the manner implied by the hon. member, but on receipt of specific information about any individual case he would be glad to inquire into it.

Electric Light in Manchester.—The Royal Exchange, Manchester, is being lighted by the British Electric Light Company, the work being carried out under the superintendence of Mr. J. M. Emmerson, of Stockport. The large central hall is to be lighted by nine arc lights, of 6,000

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candle-power, and the side corridors and offices by 210 incandescent lamps. The main entrance is also lighted by three arc lights. A Gramme machine, driven by a 25 horse-power engine, is used. The dining rooms and restaurants have been lighted with Swan incandescent lamps, by Messrs. Gooch and Hüne, of London and Manchester, Siemens alternate current machines being used, together with a Crossley 12 horse-power gas engine. At present there are 154 lamps in operation, but in the winter months this number will be increased to 210. The 154 lamps are at present on one circuit; but when the larger number are employed it is intended, we believe, to introduce Faure accumulators to supply the other lamps.

LEGAL.—SEAVER V PHILIPPART.—This was an action brought by Mr. F. I. Ricarde-Seaver, against M. Philippart as President of the Société la Force et la Lumière, a Belgian company, to restrain the issue of any shares in the Faure Electric Accumulator Company of London to the above-mentioned Belgian company until 5 per cent. commission on such shares had been paid to Mr. Ricarde-Seaver, on account of certain services rendered by him to M. Philippart. We referred to this case in a note in our issue of June 3, when an interim injunction was granted by Vice-Chancellor Hall. The case came before Mr. Justice Kay, sitting for Vice-Chancellor Hall, on the 15th instant. The evidence relied upon by the plaintiff was a letter, dated 6th April, 1882, in which M. Philippart had agreed to give Mr. Seaver a commission of "an amount equal to 5 per cent. of the net profits either in money or shares," which might be realised by the Belgian company. Mr. Justice Kay held that the terms of the letter did not entitle the plaintiff to any specific portion of or charge upon the shares in question, and he accordingly refused the application.

NEW FORM OF ELECTRIC LIGHTING MAINS.—A new form of underground main for conducting powerful currents, such as are used for electric lighting or for manufacturing and motive purposes, has recently been invented by a Detroit man. The main consists of a No. 6 copper wire, which is placed exactly in the centre of a copper or brass tube about $\frac{7}{8}$ inch in diameter and 1-16 inch in thickness. The wire is insulated from the tube by means of an insulation consisting of a mortar or putty made in the most refractory sulphate of lime mixed with a heavy oil, and injected by means of heat into the tube. The copper tube is wound with kerite tape, and, being surrounded by a layer of the insulating material, is encased in a protecting pipe of iron—a common $1\frac{1}{2}$ inch gas-pipe. The main is intended to be made in sections of 12 to 15 feet, which connect with one another by means of screw-joints. When the end of the line is arrived at, a metal cap, insulated from the gronnd, is screwed on, thus closing the circuit. The main has at certain fixed points—for instance, every 1,000 feet—a box at which the circuit may be "short-circuited," in order to facilitate any repairs which in the course of human events may become necessary.—*Operator*.

ELECTRIC LIGHT WIRES AND FIRES.—Mr. Drummond, British Secretary of Legation at Washington, makes some remarks on fires caused by electric lights in a recent report. He calls attention to a report by Inspector McDevitt, of Philadelphia, on a fire which took place at Randolph Mill, and which was attributed to the circumstance that wires were fastened to the ceilings and walls, without insulation, by bare iron staples. According to another authority fires originated in one of the largest manufacturing houses in that city on more than one occasion, though in these cases the wires were insulated. One of the staples, however, had worn through the covering until the two metal surfaces touched. It then only required moisture in the wood of the rafter to draw the sparks into the dry wood beyond. On the first occasion water was dashed on the place, but it was found that it only increased the flames, and the fire could only be extinguished by tearing the wires down bodily. Unaccountable fires are said to have originated under the cornices of houses in New York, which it is reported can only be explained on the supposition that an electric wire passing over the roof had been carelessly allowed to rest upon the tin or galvanised iron surface, which was in contact with wood underneath.

WEATHER FORECASTS.—In the House of Commons, on Friday (23rd June), Mr. Birkbeck asked the Postmaster-General whether he would allow the daily weather forecasts issued by the Meteorological Office to be sent to, and exhibited at, every postal telegraph office throughout the agricultural districts for the benefit of farmers during the hay season and harvest. Mr. Fawcett said:—"This subject has already been brought under my notice by my hon. friend the member for Newark (Mr. Earp), and, according to a promise I gave at the end of last Session, I have very carefully looked into the matter to which the question of the hon. member refers. I regret that I do not see my way to accede to his request, because it appears that if the Government supplied telegrams gratuitously to those interested in agriculture it would be impossible to refuse similar applications from those engaged in other trades. I believe that there would be little difficulty in securing the object desired. I understand that the Meteorological Office supplies the weather forecasts gratuitously to anyone who is willing to pay the expenses of telegraphing them, which is very rarely more than one shilling. If, therefore, the farmers in any district jointly subscribe, the expense to each would be very inconsiderable. The forecast might be exhibited at the post-office, and in the case of those farmers who resided within the area of free delivery the messages could be delivered at the small extra cost of 3d. for each additional copy."

SIXPENNY TELEGRAMS.—A letter appeared in *The Times* of Thursday over the signature "Telegram," in which the writer alludes to the statement made by Mr. Fawcett in the House of Commons, given in full in another column, and criticises the refusal of the Government to allow the experiment of sending sixpenny telegrams for a certain period to be made. The writer says:—"Why the Government should have declined to make such an experiment when no loss could possibly accrue to the revenue is one of those matters which can only be understood by a permanent official. The refusal to test an experiment which could be conducted without cost seems to the ordinary mind to be the grandest proof of the bureaucratic obstruction to all improvement which is believed to prevail to a large extent in the Government offices. The question raised, however, by Mr. Stanhope leads to broader considerations than a mere experiment in telegraphic facilities. It can hardly be doubted but that if the telegraphic wires of the country were in the hands of private companies and were administered by private enterprise, instead of being a Government monopoly, the public would gain largely in rapidity, cheapness, and extension of telegraphic communication. It appears more than doubtful whether the monopoly given by Parliament and the purchase by the Government of the telegraph lines in the United Kingdom have not proved to be errors, and whether the time will not shortly arrive when the administration of telegraphy should be taken out of the hands of the Government and again intrusted to private enterprise." Our opinion on this matter will be found in our leading article.

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ON THE SEVERAL SYSTEMS OF UNITS FOR ELECTRIC AND MAGNETIC MEASUREMENTS.*

BY R. CLAUSIUS, HON. M. INST. C.E.

There are two systems of units for electrical measurements —the electrostatic and the electro-dynamic. In describing the derivation of these systems from the fundamental units of mass, length, and time, the author in general follows Maxwell's treatise ("Electricity and Magnetism"); but points out an error in the dimensions of the electrostatic unit of magnetic quantity. This is deduced from the electrostatic unit of electricity by means of Ampère's theory. Consider two equal plane figures of unit area bounded by closed curves, in parallel planes, indefinitely near each other. Let currents of unit strength flow in opposite directions round these curves, and denote the perpendicular distance between the planes by $\epsilon\,\pi$, where π is the unit of length, and ϵ a numerical quantity. Then by Ampère's proposition such a system produces the same effects as if the figures had been uniformly coated with an amount $\frac{m}{e}$ of magnetic matter of opposite signs, m being the unit of magnetic quantity; and the magnetic moment is equal to the product of the current intensity and the area. Hence—

$$\frac{m}{\epsilon}\,\epsilon\,\pi = e\,\pi^2\,\tau^{-1},$$

or

$$\frac{m}{e} = \pi\,\tau^{-1}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Now the dimensions of e_s, the electrostatic unit of electricity, are $\mu^{\frac{1}{2}}\,\pi^{\frac{3}{2}}\,\tau^{-1}$, and of m_d, the electro-dynamic unit of magnetic quantity $\mu^{\frac{1}{2}}\,\pi^{\frac{3}{2}}\,\tau^{-1}$, μ denoting the unit of mass, and τ the unit of time.

Hence

$$m_s = \mu^{\frac{1}{2}}\,\mu^{\frac{5}{2}}\,\tau^{-2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and

$$e_d = \mu^{\frac{1}{2}}\,\pi^{\frac{1}{2}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Maxwell derives his units from the equations

$$m\,c = \frac{\pi^2\,\mu}{\tau^2} \quad \text{and} \quad \frac{e}{c} = \tau,$$

where c is the unit of current.

Hence

$$e\,m = \mu\,\pi^2\,\tau^{-1};$$

therefore

$$e_d = \mu^{\frac{1}{2}}\,\pi^{\frac{1}{2}}.$$

But the equation is only applicable to the electro-dynamic system, and when applied to the electrostatic system gives the wrong result,

$$e_s\,m_s = \mu\,\pi^2\,\tau^{-1},$$

and therefore

$$m_s = \mu^{\frac{1}{2}}\,\pi^{\frac{1}{2}}.$$

After defining the other electrical units, the author compares the two systems. The force between two electrostatic units of electricity at unit distance is the unit of force, and is therefore equal to $[e_s^2\,\pi^{-2}]$. Let $k\,[m_s^2\,\pi^{-2}]$ represent the force between two electrostatic units of magnetic quantity at unit distance. This can be written $k\,[\pi^2\,\tau^{-2}]\,[e_s^2\,\pi^{-2}]$. But the last factor is the unit of force, and the whole expression is a force; hence k is the reciprocal of the square of a velocity, called by the author the critical velocity, and denoted by K. The force between two electrostatic units of magnetic quantity at unit distance is, therefore, $[\pi^2\,\tau^{-2}]\,[\mathrm{K}^{-2}]$ of a unit of force, but the force between two electro-dynamic units of magnetic quantity at unit distance is the unit of force; hence, since the forces vary as the squares of the quantities, the ratio between the magnetic units is as K to $[\pi\,\tau^{-1}]$. This can be expressed by the equation

$$\frac{v.\,s.\,[m_d]}{[m_s]} = \frac{[m_d]}{v.\,d.\,[m_s]} = \frac{\mathrm{K}}{\pi\,\tau^{-1}},$$

where the prefix $v.\,s.$ denotes that the electro-dynamical unit is expressed in electrostatic measure, and $v.\,d.$ that the electrostatical unit is expressed in electro-dynamic measure. By means of the former equations this equation gives

$$m_s = \mu^{\frac{1}{2}}\,\pi^{\frac{5}{2}}\,\tau^{-2}; \quad m_d = \mu^{\frac{1}{2}}\,\pi^{\frac{3}{2}}\,\tau^{-1}.$$

From equation (1)

$$[e_s] = [m_s]\,[\pi^{-1}\,\tau]; \quad [e_d] = [m_d]\,[\pi^{-1}\,\tau].$$

Hence

$$v.\,d.\,[e_s] = v.\,d.\,[m_s]\,[\pi^{-1}\,\tau]; \quad v.\,s.\,[e_d] = v.\,s.\,[m_d]\,[\pi^{-1}\,\tau],$$

and

$$\frac{v.\,s.\,[e_d]}{[e_s]} = \frac{[e_d]}{v.\,d.\,[e_s]} = \frac{\mathrm{K}}{[\pi\,\tau^{-1}]},$$

and

$$e_s = [\mu^{\frac{1}{2}}\,\pi^{\frac{3}{2}}\,\tau^{-1}]; \quad [e_d] = [\mu^{\frac{1}{2}}\,\pi^{\frac{1}{2}}].$$

The units of resistance, current, capacity, and electromotive force are similarly deduced.

As the Paris Electrical Congress has decided to give the name of Ampère to the practical unit of current, the author proposes to reserve the name Weber for the electro-dynamical unit of magnetic quantity. The system of units in practical use is then

$$\text{Weber} \ldots\ldots\ldots \quad [m_d] = g\,r^{\frac{1}{2}}\,c\,m^{\frac{3}{2}}\,s^{-1}\,10^8 = p^{\frac{1}{2}}\,q^{\frac{3}{2}}\,s^{-1}.$$

$$\text{Coulomb} \ldots\ldots \quad [e_d] = g\,r^{\frac{1}{2}}\,c\,m^{\frac{1}{2}}\,10^{-1} = p^{\frac{1}{2}}\,q^{\frac{1}{2}}.$$

$$\text{Ampère} \ldots\ldots \quad [i_d] = g\,r^{\frac{1}{2}}\,c\,m^{\frac{1}{2}}\,s^{-1}\,10^{-1} = p^{\frac{1}{2}}\,q^{\frac{1}{2}}\,s^{-1}.$$

$$\text{Volt} \ldots\ldots\ldots\ldots \quad [\mathrm{E}_d] = g\,r^{\frac{1}{2}}\,c\,m^{\frac{3}{2}}\,s^{-2}\,10^8 = p^{\frac{1}{2}}\,q^{\frac{3}{2}}\,s^{-2}.$$

$$\text{Ohm} \ldots\ldots\ldots \quad [\mathrm{R}_d] = c\,m\,s^{-1}\,10^9 = q\,s^{-1}.$$

$$\text{Farad} \ldots\ldots\ldots \quad [\mathrm{C}_d] = c\,m^{-1}\,s^2\,10^{-9} = q^{-1}\,s^2.$$

In the second column the unit of mass p being taken as $1^{gr}\,10^{-11}$, the unit of length q as $1^{cm}\,10^9$, and the unit of time remaining the second.

The author concludes by describing a new system, which he calls the critical system. The ratio of each unit in the dynamical system to the corresponding unit of the statical system is equal to the ratio, or a power of the ratio of the critical velocity to the unit of velocity; hence, if the unit of velocity be chosen equal to the critical velocity, this ratio will in each case be unity. It is convenient to keep the second as the unit of time. The unit of length (λ) is therefore the space passed over in a second by a point moving with the critical velocity; and is equal approximately to 30 quadrants of the meridian. The unit of mass (μ) is chosen, so that the units of currents and quantity retain the same value in the new system as in the practical system. Since

$$[e_d] = p^{\frac{1}{2}}\,q^{\frac{1}{2}} \text{ and } [i_d] = p^{\frac{1}{2}}\,q^{\frac{1}{2}}\,s^{-1},$$

and

$$[e_d] = \lambda^{\frac{1}{2}}\,\mu^{\frac{1}{2}} \text{ and } [i_d] = \mu^{\frac{1}{2}}\,\lambda^{\frac{1}{2}}\,s^{-1},$$

if the values of the units remain the same

$$\mu = p\,\frac{q}{\lambda}.$$

This makes μ approximately equal to $\frac{1}{3}\,10^{-12}\,c\,m$. The critical system is then

$$[m_d] = v.\,d.\,[m_s] = \mu^{\frac{1}{2}}\,\lambda^{\frac{3}{2}}\,s^{-1} = \frac{\lambda}{q} \text{ weber.}$$

$$[e_d] = v.\,d.\,[e_s] = \mu^{\frac{1}{2}}\,\lambda^{\frac{1}{2}} = 1 \text{ coulomb.}$$

$$[i_d] = v.\,d.\,[i_s] = \mu^{\frac{1}{2}}\,\lambda^{\frac{1}{2}}\,s^{-1} = 1 \text{ ampère.}$$

$$[\mathrm{E}_d] = v.\,d.\,[\mathrm{E}_s] = \mu^{\frac{1}{2}}\,\lambda^{\frac{3}{2}}\,s^{-2} = \frac{\lambda}{q} \text{ volt.}$$

$$[\mathrm{R}_d] = v.\,d.\,[\mathrm{R}_s] = \lambda\,s^{-1} = \frac{\lambda}{q} \text{ ohm.}$$

$$[\mathrm{C}_d] = v.\,d.\,[\mathrm{C}_s] = \lambda^{-1}\,s^2 = \frac{q}{\lambda} \text{ farad.}$$

Though this system is of no practical use, since the critical velocity is not sufficiently accurately known, it is of theoretical value from the agreement of the electro-dynamic and electrostatic units.

* Abstracts of Papers in "Foreign Transactions and Periodicals," published by the Institution of Civil Engineers, Vol. LXVIII., Part 2.

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SAFETY JUNCTIONS AND PLUGS FOR INCANDESCENT LIGHTING.

Messrs. Edmunds and Co., Halifax, Yorkshire, have lately designed and registered a new form of safety plug, to supply a want greatly felt in making installations of electric lighting upon the incandescent principle. Until their introduction, the only safety plug in the market was that devised by Mr. Edison, and not only were they far from perfect either in operation or appearance, but unattainable by those who wished to use any system but the Edison.

Instead of lead wire, which oxidises, and is eaten away by exposure, Messrs. Edmunds and Co. employ tin, lead, or other metal foil, so attached to an insulating substance, that neither

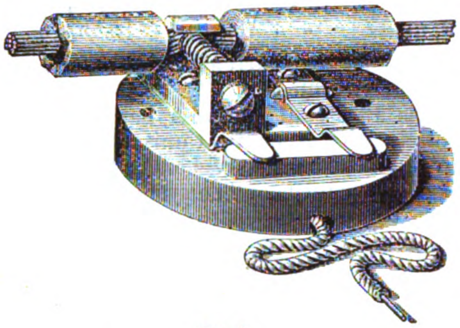


Fig. 1.

heat nor damp will loosen it; and of such bulk that it will carry enough current for one lamp, and but little more. The foil is of such a shape and section as to "go" always in the centre of the plug upon a lamp being short-circuited, thus preserving the contacts bright and clean. These little plugs can be punched out from a sheet of material with great ease, and from their very nature cost but little.

The main lead is attached to the screw junction as shown by baring the wire of its dielectric for about the width of the junction, and placing the bared wire in the junction, and then screwing up tightly. The current passes from the main lead through the junction and spring to the fusible or safety plug, then on to the second spring, and so on by the small wire to the lamp. The whole safety junction is then covered

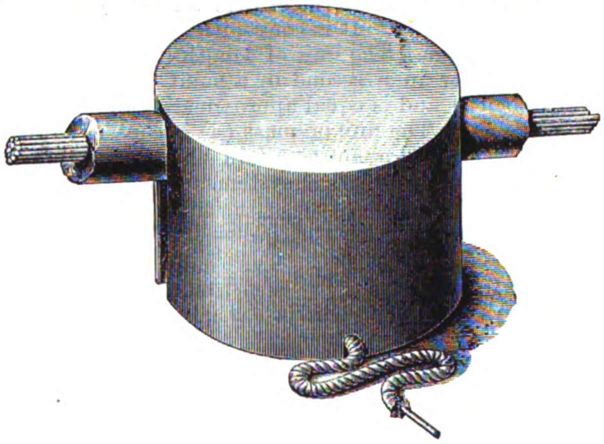


Fig. 2.

over by the cap as shown in the second figure, this being done after the junction has been screwed to the wall by two screws passing through the wooden disc as shown.

When a number of lamps are to be grouped together, as in an electrolier, it is inconvenient to place a number of safety junctions together, and such an arrangement would appear unsightly. The firm before mentioned have, therefore, brought out a registered arrangement, by which a number of plugs can be grouped together under one cover. This is shown in the third figure, which represents an 8 plug box. The main lead is attached to the screw junction, as described before, and each lamp has a wire attached to a little terminal outside the box, as shown. By this means every lamp in the electrolier in question has its fusible safety plug, and the whole number are easily got at to replace one when burnt. The foil has been so proportioned that it "goes" without making the other lamps "jump" in the least. A number of these useful and really necessary little articles are already in use, and so far have answered the purposes for which they are made admirably.

Fig. 3.

In the numerous installations made by Messrs. Edmunds these appliances are extensively employed, and are now coming into general use with those companies who do most of the incandescent electric lighting in this country.

MILNER'S WIRE GAUGES.

We illustrate two forms of wire gauge, recently patented by Mr. Milner, which are a decided improvement on the old

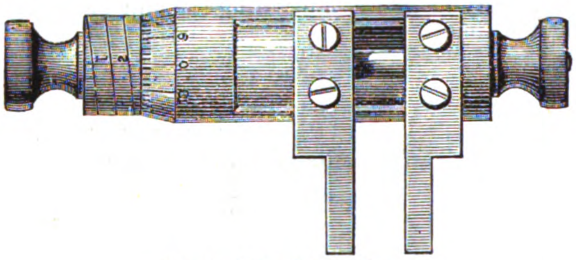


Fig. 1.—Milner's Wire Gauge.

form hitherto in use. The principle of both of them is that of the well-known diagonal scale. In the form represented

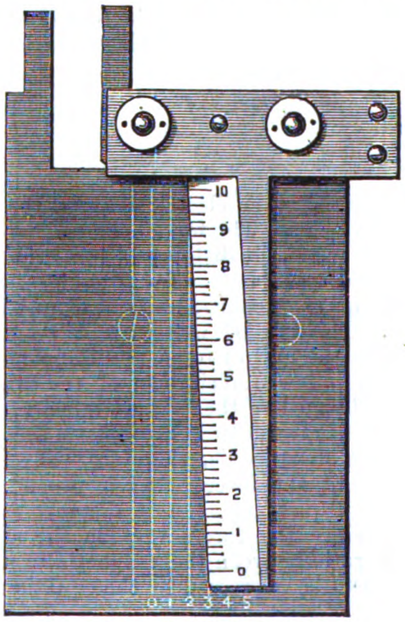


Fig. 2.—Milner's Wire Gauge.

in Figure 1, the scale is described as a spiral line round a cylinder.

In the other form, Fig. 2, the reading is obtained by the

edge of the bar, inclined as shown, which moves over the surface of the flat plate. One of these is marked for measurements up to ·5 inch, whilst the other has ten sets of figures by means of which measurements up to ·001 inch can be made. The bar is compelled to move properly by a simple parallel rule arrangement at the back of the plate.

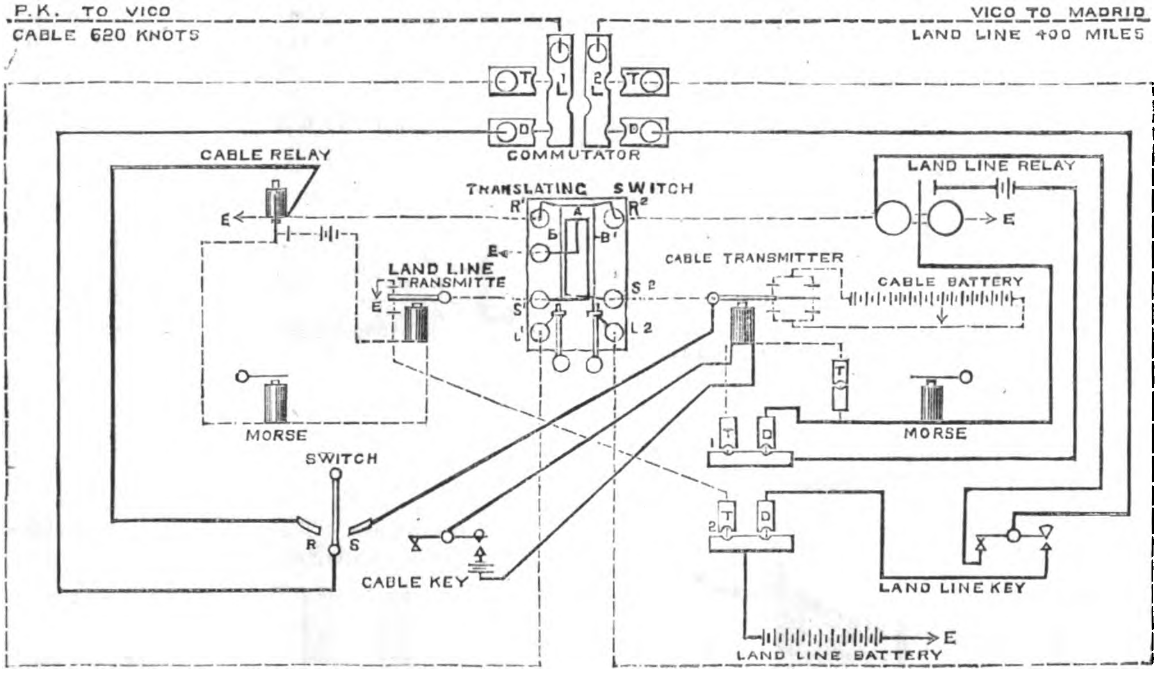
One great merit of these little gauges is that they are far handier than the old form, and can be held in one hand only, leaving the other free to manipulate the wire. Both inside and outside measurements can be obtained with them.

They are manufactured by Messrs. Elliott Brothers, of the Strand, and this is a sufficient guarantee for their accuracy. The instruments we have seen show excellent workmanship. Our illustrations represent the instruments full size.

THE CRYSTAL PALACE EXHIBITION.

Eastern Telegraph Company.

We herewith illustrate Saunder's translating arrangement as used on the lines of the Eastern Telegraph Company, and shown by that company at the Crystal Palace Exhibition.



NOTE
DOTTED LINES = TRANSLATING CIRCUIT. SOLID LINES = DIRECT WORKING

Saunders' Translating Arrangement.

The diagram shows the apparatus and the way in which the various parts are connected; the only parts requiring explanation are the translating switch and the cable transmitter. The translating switch consists of two levers, having a vertical movement, and connected respectively with terminals L^1 and L^2, and a vertical block of vulcanite, A, having three contacts on each side, with which the springs B B^1 of the levers make contact. The contacts on each side at the bottom of the block are connected respectively with terminal R^1 and R^2, the contacts on the top of the block are connected to S^1 and S^2, intermediate contacts between R^1 R^2 and S^1 S^2 are connected to the terminal E.

The levers are so arranged that the springs B B^1 can both be put on to the contact R^1 R^2 of A, but are so connected together that depressing one raises the other and *vice versâ*, so that the levers are alternately in contact with the top and bottom contacts on A, as one or other of the levers is depressed.

The cable transmitter has, in addition to rigid contacts, rubbing spring contacts so as to insure perfect signals on the cable, and this transmitter sends the current through the cable whether working translation when it is actuated by the local battery of the land line relay, or working in sections when it is actuated by the local battery of the cable key.

The action is as follows for working translation from Porthcurnow to Madrid, through Vigo:—The apparatus being connected up as shown by dotted lines in the diagram, plugs being inserted into the commutator and plug switches marked T, both levers raised so that the springs B B^1 rest upon the *lower* contacts on vulcanite block A; then the cable and land-line are connected to their respective relays, so that either station can call up the intermediate or terminal station. Should Porthcurnow call up Madrid, the intermediate station, Vigo, would depress the right-hand lever, and thus place the land-line in connection with the land-line transmitter, putting Porthcurnow in translating circuit with Madrid. Thus the current sent from Porthcurnow would pass through commutator L^1 T to translating switch lever L^1 to lower contact on A through cable relay to earth. The cable relay corresponding to this current would actuate land-line transmitter, which would send corresponding currents on to Madrid through terminal S^1 connected to top right-hand contact on A by right-hand lever connected to terminal L^2 and thence to commutator L^2 T. On Madrid wishing to send to Porthcurnow the clerk at Vigo would depress the left-hand lever, which would reverse all the connections. The land-line relay would now respond and bring into play the cable transmitter, and so on alternately.

The one action of depressing either of the levers raises the other so that the springs B B^1 rest alternatively on the top or bottom contacts of A.

The intermediate contacts (connected to earth) between the top and bottom ones on A discharge the lines as they come in contact with them in passing.

For direct working with Vigo to terminal stations plugs are inserted in the holes marked D. The connections are shown by the strong lines, the connections being as usual, except that the currents are sent into the cable by the cable transmitter actuated by a local battery connected to the cable key.

Hornsby's Portable Engine.

Among the many excellent engines in work at the Cryst-

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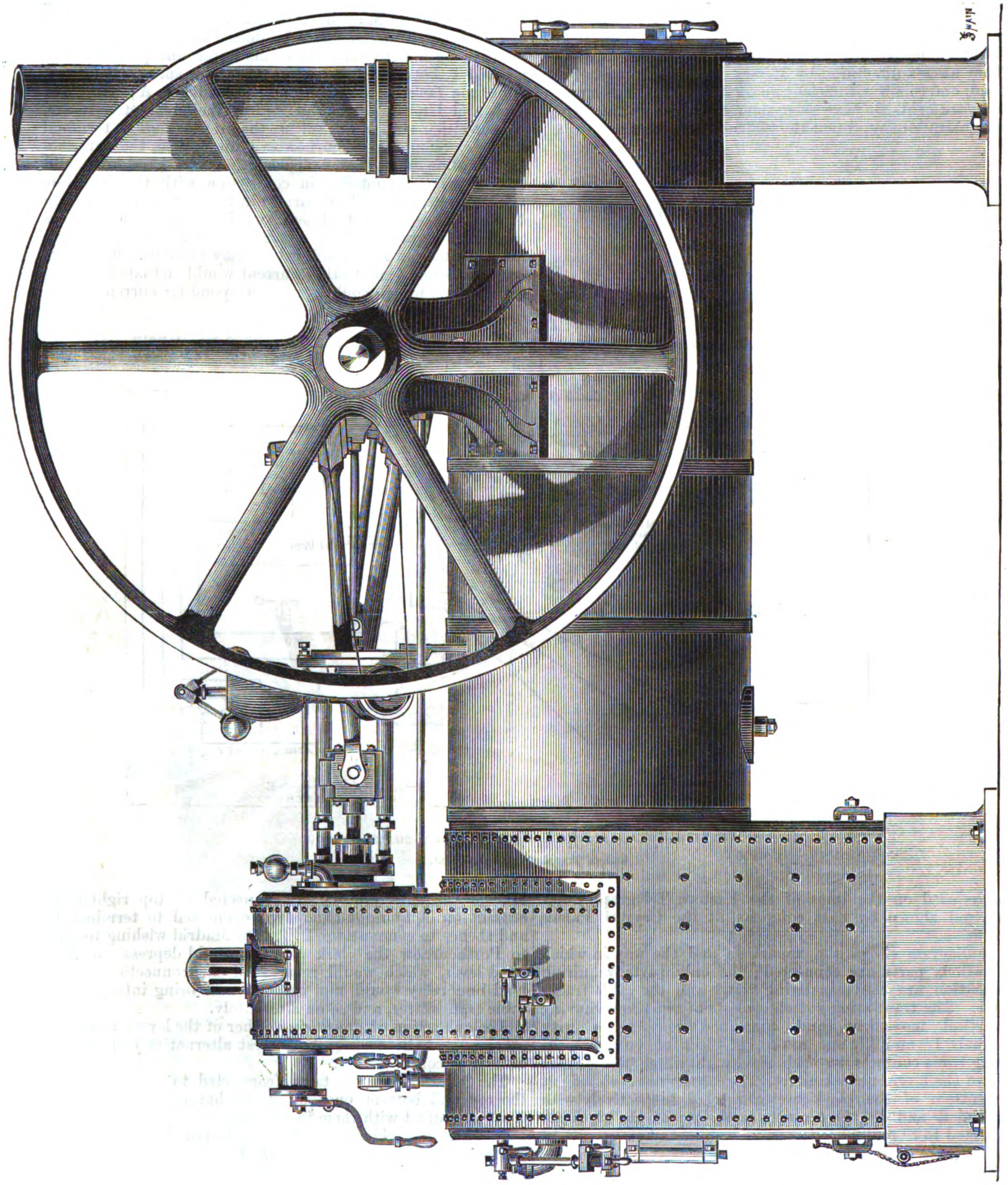
Palace was the one which we now illustrate. It is a double cylinder portable engine by Messrs. Hornsby and Sons, of Grantham. The cylinders are 7·5in. diameter and 14in. stroke. The heating surface is 173 square feet, the fly-wheel is 7ft. in diameter, making 135 revolutions per minute. The engine was used for driving one 7 A Brush machine at about 750 revolutions per minute. The cylinders are fixed in a case of plate iron upon the top of the fire box, and the valve chests, cylinders, &c., are all perfectly jacketted by being enveloped in the boiler steam.



Hornsby's Portable Engine, for Driving Electric Light Machinery.

Cable Broken.—The island of Mull, Scotland, is at present cut off from telegraphic communication with the mainland, the cable being broken near the Mull shore.

Brazilian Submarine Telegraph Company.—The traffic receipts of this company for the week ended 16th ult. amounted to £2,943.

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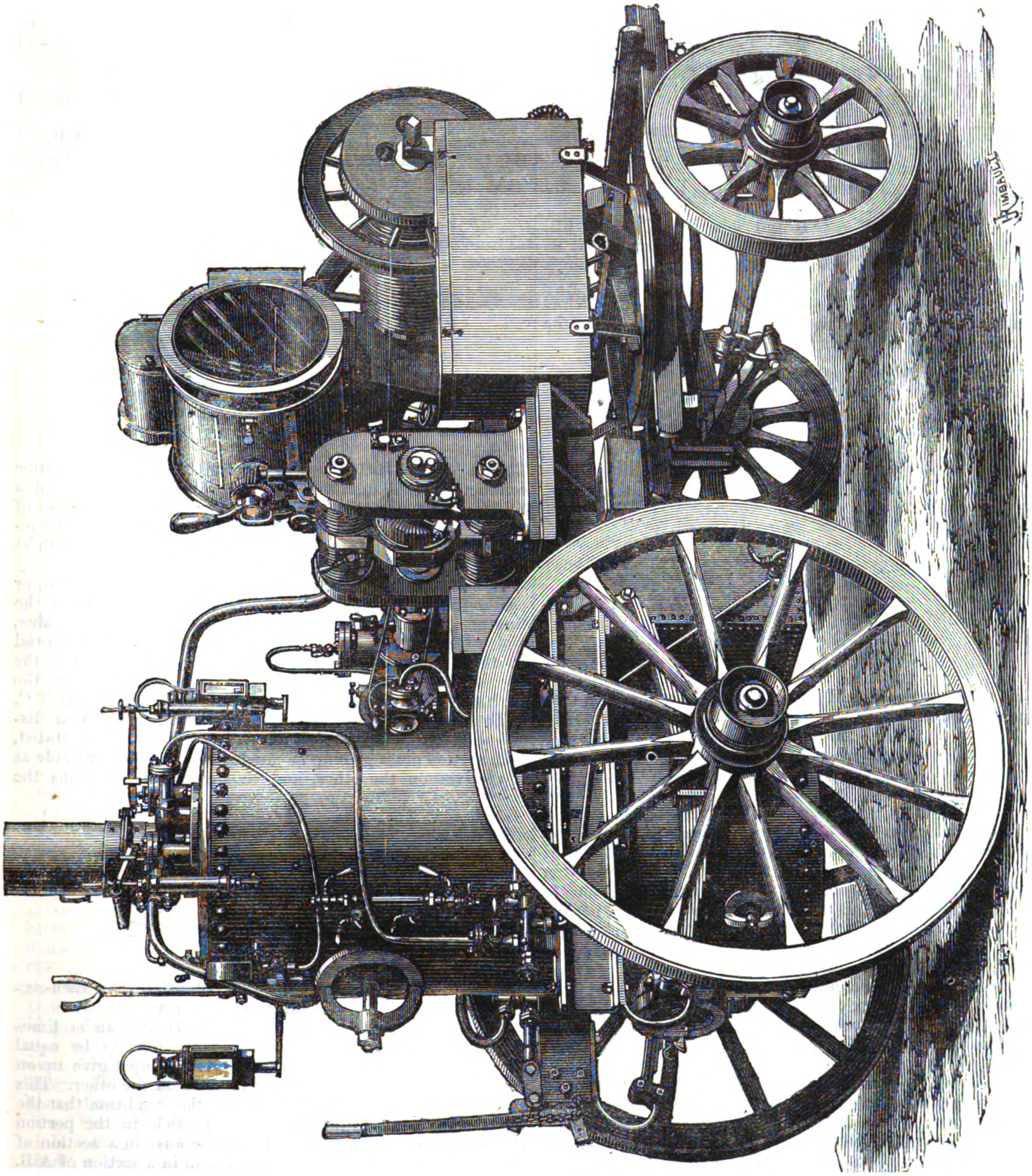
PORTABLE ELECTRIC LIGHT PLANT.

We herewith illustrate the portable electric light plant, as constructed by Messrs. Sautter, Lemonnier, and Co., of the Avenue de Suffren, Paris, for the French Government. It is intended to be used for military service, but can obviously be employed in many other directions. The illustration almost explains itself. The engine is a portable one, with a Gramme dynamo machine and regulator fitted on the same carriage. The dynamo is driven by a Brotherhood three-cylinder engine, which will be seen on the far side of the dynamo. Combined with the regulator there is a Mangin projector and a cell carrying a certain length of insulated conductor. The plant is intended by the French Government for use in fortifications, where its portability permits of its being rapidly shifted from point to point. It is remarkably compact, and, like all Messrs. Sautter and Lemonnier's work, of excellent construction. It was shown at the Paris Exhibition.



Sautter and Lemonnier's Portable Electric Light Plant.

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THE (ELECTRIC) CONDUCTIVE AND INDUCTIVE CIRCUITS GEOMETRICALLY ILLUSTRATED.

BY F. C. WEBB, M.I.C.E.

(CONTINUED FROM PAGE 220., VOL. VIII.)

To prove the problem geometrically let A B (Fig. 9) as before represent the length of the circuit, to which its surface, inductive capacity, and resistance are proportional, and B M in the same manner the length of wire, with end M insulated, touching the circuit at B. Let C B be the potential (before the wire B is touched) on positive side of surface of generation and A F potential on negative side of same. Then before the wire B M is touched to the circuit the line of potential will be C F. It is required to find the point to which the potential at B will fall in order to make the quantity of electricity in B M (or B M multiplied by the new potential at B) equal to the quantity of electricity lost by the circuit (or A B multiplied by the old potential at B, minus the new potential at B).

Make M K and A N = C B and join N C K, which will consequently be parallel to A M. Join K A cutting B C at H. Then B H will be the new potential at B, and the parallelogram B H L M (representing the electricity in the wire B M) will be equal to the parallelogram E N C H, which is again equal to the parallelogram G F C H (representing the electricity lost by the circuit).

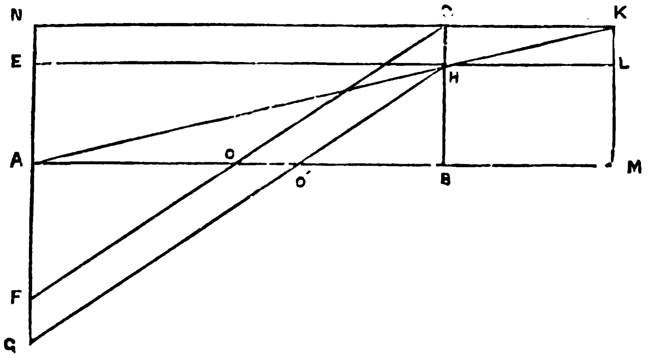

FIG. 9.

For the triangles K L H and H B A are similar, and, consequently, we have

$$KL : LH :: HB : AB$$

Consequently $LH \times HB = KL \times AB$,
but $LH = BM$, and $KL = CH$,
and $AB = EH$,
therefore $BM \times HB = CH \times EH$,

or the parallelogram B M L H, representing the quantity received by the wire B M, is equal to the parallelogram E H C N, which is equal to the parallelogram G F C H, representing the quantity lost by the circuit. H is therefore the point to which the potential at B must fall on the wire B M being brought into contact with the circuit at B. The problem is one of the gems in Ohm's celebrated paper, yet it is seldom alluded to in our text-books.*

We have here shown how a conductive body, having an inductive capacity, touching the circuit, alters the line of potential, but it will easily be seen that it follows from the same laws that the line of potential in an insulated circuit can, in a similar manner, be altered without actually touching the circuit to any conductor, by merely approaching the surrounding conductors to one particular part of the circuit, thus increasing the inductive capacity of that part which will immediately absorb electricity from the other parts, and thus alter the line of potential in the whole circuit.

We have thus far considered a circuit consisting of a single homogeneous conductor, of equal section throughout, at a single cross section of which exists a surface of excitation or generation where the electricity is generated and flows off equally from each side of this cross section. Such a circuit cannot exist in reality, but it is from such an imaginary ring that Ohm starts in his reasoning, and it is useful to bear in mind such a ring and the electrical state that would exist in it as leading up to the circuits formed of different conductors, liquid and solid, which do exist. Such a ring seen in perspective is represented in Fig. 10, where the thick line represents the ring. The cross section of excitation is at A, A P representing the positive potential immediately on one side of the cross section of excitation, and A N the negative potential immediately on the other side of the cross section of excitation, the line of potential being shown by the thin line P O N. The point O exactly half way round the ring being the point of no potential or the point where the negative and positive electricity recombine.

* This problem will be found treated of by me in the *Philosophical Magazine* for May, 1867.

We have now to consider the case of a circuit composed of several heterogeneous parts.

Let us suppose a circuit, composed of two parts, A B and B C (Fig. 11), having a single surface of excitation, A D, at A.

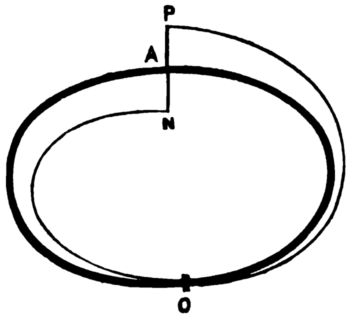

FIG. 10.

Then if A B and B C have the same section and are of the same conductivity, the case will be precisely similar to that of a circuit composed of a single conductor, A C, and the lines of potential will, if the circuit is touched to earth at C, be represented by a straight line, D E C, or if touched to earth at any other point, by some line parallel to D C.

If, however, the part B C is not of the same section, or conductivity as A B, then this constant inclination of the line of potential throughout the circuit no longer obtains, and we must seek for the position of the line of potential in these altered conditions of the case. For instance, the line of potential might, under certain conditions, assume the position D E′ C, or under other conditions the position D E″ C.

The first fundamental law determines, in fact, this distribution of the potential, for, as has already been stated, each section must give up as much electricity on one side as it receives on the other, and this condition occasions the

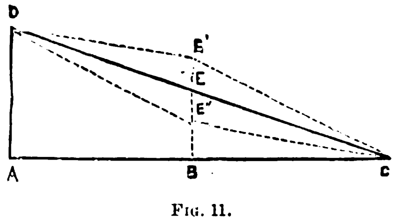

FIG. 11.

uniform inclination of the lines of potential when each section of the conductor is similar in every respect.

Let us now suppose that the part B C has an m times smaller section than A B; then for the flow to be equal throughout the whole circuit, each section must give up on one side as much electricity as it receives on the other. This state can evidently only exist under the condition that the electric transition from particle to particle in the portion B C is m times greater than in A B, because in a section of B C there are m times less particles than in a section of A B. But in order to produce this m times greater transition of the electricity from particle to particle, the differences of potential from particle to particle must, according to the first fundamental law, be m times greater than in the portion A B; or, in fact, the lines E′ C must sink m times more on equal portions of the line B C than D E′ does on equal portions of A B. Or, in fact, the line E C must have an m times greater inclination or dip than D E′. The lines of

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potential will in this case, therefore, take a position represented by D E′ C.

From these considerations the following rule results:—*The dips of the lines of potential in different parts of a galvanic circuit composed of like substance are inversely as the sections of those parts.*

And in the same way:

When the parts A B and B C are of like section, but of material possessing different conductive powers, the dips of the lines of potential in each are inversely as the conductivities of those parts.

And, lastly, if the *two parts A B and B C have different sections, and are composed of materials of different conducting powers, the dips of the line of potential are inversely as the products of their sections and conductivities.*

Thus, if A B, being equal in length to B C, had double the section of B C, and was composed of a material having twice the conductivity, the dip of the line of potential in A B would be a quarter that in B C. Thus, D A — E′ B must equal one-fifth A D, or, in fact, E′ B must equal four-fifths of A D. If A B is not equal to B C, then the line of potential in B C *must in a distance equal to A B* sink exactly four times as much as the line of potential in A B does in A B.

If the part B C, on the contrary, had twice the section and twice the conductivity of A B, then the line from A to B would be steeper than that in B C, as shown by the line A E″ C.

In the same way, if we have a galvanic circuit composed of several different parts, the dips of the line of potential in each part will be inversely proportional to the products of their conductivities and sections.

Thunderstorms.—Heavy thunderstorms are reported as having taken place in various parts of the country in the latter part of last, and the early part of this week, accompanied in some instances by damage to property and loss of life. At the village of Llandyssil, in Carmarthenshire, on Monday, a number of cows were killed by lightning.—A Durham on the preceding Friday, during a heavy thunderstorm, the lightning struck a trap let into the cavity of the trench by which the telegraphic wires are carried up Silver-street. The trap consisted of a block of stone with an iron frame, the latter half an inch thick. The stone, a foot and a-half long and weighing about a half hundredweight, was thrown several feet into the air and smashed, whilst the iron framework was torn off and twisted out of all shape.—At a church in Ormskirk, near Liverpool, on Sunday, during evening service, the congregation were terrified by a sudden report and flash, and what appeared like a ball of fire passed through the church from the north-east. A panic ensued for a short time, but it was allayed by the vicar and curate, when it was found that no one was hurt. Subsequent examination proved that the lightning had struck the steeple, shattering some of the stonework inside, but leaving very little trace outside.—At Runcorn, also, near Liverpool, a house was struck, the lightning making a large hole in the outer wall, passing into the room, and damaging the window casing, but otherwise doing no damage.—At Dalkeith, in Scotland, on Saturday, the roof of the High School was struck and considerably damaged, as also was one of the chimney stacks.—At Dysart, on the same day, the lightning struck the chimney of the Victoria Linen Works, Sinclairtown.—At Sirenhill, in the Stonehouse District, Scotland, on Saturday, the lightning passed down the chimney of a house, knocking over a woman and child sitting by the fire-place, but not seriously hurting them; a man walking on the road at the same place was also knocked down, but though shaken, not otherwise hurt. The same storm seems to have visited Keith, where a valuable horse belonging to Mr. Mitchell, of Cairnie, was killed; the animal had been standing by a wire fence, and it is supposed that the lightning travelled along the fence.—At Selkirk the telegraph instruments were put out of gear by having their coils fused, and, consequently, telegraphic communication was interrupted for six hours.

CORRESPONDENCE.

WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I know nothing of Mr. Harbord's person or his belongings, therefore his insinuation of my having used "personalities" falls to the ground. The extraordinary nature of his first letter of denials unsupported by proof, or the possibility of proof, certainly entitled me to note that it did not require a wise man to write it; and his second letter to you is still void of any evidence that he really has any practical knowledge about electricity, while it displays a great deal of slipperiness. He attempts to institute a parallelism between the human voice passing through a window and electricity passing through the glass of a Leyden jar. Windows, as usually constructed, are not air tight. Every man of common scientific attainments knows that sound cannot pass where there is no air. It cannot pass through a vacuum that electricity can pass through. There is no true parallelism between the two cases. Mr. Harbord was either ignorant of the foregoing facts, or if not, he instituted the attempted parallelism to evade answering my question about electricity, which if he had answered, his answer would have afforded evidence that assertions in his first letter are not true.

The contents of his first letter indicate that he was ignorant of the fact that electricity passes through glass. In his second letter he admits that electricity passes through glass, but asserts "The glass of Mr. Johnstone's jar is non-conducting." What right has he to make such an assertion when he has no means of proving the truth of it, and when the assertion is in direct contradiction to the experimental proofs which I gave in my letter, page 61, that the glass of the Leyden jar did conduct electricity up to the moment that the jar became fully charged internally with electricity, and then the glass ceased to conduct the electricity, a discovery which is new in the science of electricity and gives us the means of knowing the true theory of the action of the Leyden jar.

Mr. H. denies that he believes in two electricities or even in one electricity, and "recognises only a figure of speech conveying the idea of an active agent producing certain effects;" yet, after all, he writes about the charge of a Leyden jar being "not retained because it is neutralised by reunion through or over the surface of the glass." Now this something which can reunite must have been previously separated into parts, proving that Mr. Harbord has in his mind's eye something more tangible than "a figure of speech;" but he won't come out with the information, as it would be tantamount to answering the question I put to him about electricity, a step which would result in showing the inconsistency of his writings.

If the glass of which a given Leyden jar is made be an absolute non-conductor of electricity, this jar virtually would be the same as a Leyden jar which is perfectly insulated. Now we know by practical experience, not only by my experiments, but by the experiments of others, that a Leyden jar which is perfectly insulated cannot receive a charge of electricity, hence we know that the glass of every ordinary good working Leyden jar must be to some extent a conductor of electricity. My experiments have proved that the glass of every efficient Leyden jar does allow electricity to pass through it to a large extent at the commencement of charging, but growing less and less in the amount of electricity passing through the glass as the charging proceeds up till the time the jar is fully charged with electricity, and then the passage of the electricity through the glass stops. It was the discovery of these facts which enabled me with certainty to announce *that static induction is a myth*, whether its supposed origin was supported by Faraday's theory of two forces or Mr. Harbord's theory of "a divisable figure of speech." If Mr. Harbord writes another letter to you, and if it does not contain a plain statement of the action which takes place when a Leyden jar is charged and discharged, I shall not answer his letter.—Yours, &c., James Johnstone.

Experiment Rooms, 1, James-square, Edinburgh,
26th June, 1882.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 396, Strand, London, W.C.

All letters intended for insertion in THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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SIXPENNY TELEGRAMS.

Though disappointed at the reception accorded by the Government to their motion, the advocates of sixpenny telegrams, both in and out of Parliament, have reason to be satisfied with the result of the division which followed. When as many as seventy-seven members can be induced to vote against the Government on a question of this sort, we may be sure that it is coming rapidly within the sphere of practical politics. We may concede this much in respect to the resolution of last Monday evening, which was rejected only by a majority of seventy-one. It would be wrong, however, to attach too much significance to the numbers. Something is to be gained in popularity by voting even for an abstract resolution; and as nothing can possibly come of it if the Government are so minded, there are always plenty of members ready to make capital out of the opportunity. Sixpenny telegrams would be very nice; we cannot have them—but we can vote for them. To get them would seriously injure the revenue; to go into the lobby for them injures nobody.

Some such reasoning as this, we imagine, must have actuated the gentlemen who consented to follow Mr. Cameron despite the explicit declarations of both the Postmaster-General and Mr. Gladstone that the object of his resolution could not be conceded. Perhaps, too, the wording of it had something to do with the voting. The resolution ran as follows: "That the working of the Postal Telegraph service with a view to the realisation of profit involved a tax upon the use of telegrams; that any such tax is inexpedient; and that the profit derived from the service is now such that the charge for inland telegrams should be reduced." Anybody could vote for the two first clauses of this resolution, and as to the third, in affirming what was not strictly true, its supporters probably thought they were helping to make it true. And no doubt they were; for if any considerable number of persons insist that there is now a profit on the service capable of being utilised in a certain way, when it can be shown that there is no such profit, the force of their convictions when the profit really does arise will be irresistible. We may say, therefore, that a reduced tariff for inland telegrams is one very big stride nearer, though it will not be upon us yet awhile.

The arguments in favour of the reduction were as usual of the meagrest description. The figures adduced by the mover and seconder of the resolutions were shown to be inaccurate or fallacious, and the main reasons in support of it are embodied in the resolution itself. Working the postal telegraph for profit does undoubtedly involve a tax upon the use of telegrams, just as working the Custom House for profit involves a tax upon the use of commodities. That the Telegraphs and the Post Office are supposed not to be worked for profit, whilst in such departments as the Customs and the Excise profit forms the primary object, is a mere accident. The Government taxes locomotion in several different ways, and that it should refrain from taxing communication is by no means an obvious proposition. Such a tax is inexpedient says the member for Glasgow; but it all depends on whether the proceeds are wanted. If they are wanted, it would be difficult to find a source of revenue less objectionable than this of the telegraphs. It taxes precisely the people who profit by it—that is to say the people who use it; and this is a merit which can be claimed by only a very few national imposts. Mr. Gladstone, so far as we can gather from the brief report of his speech, held to the doctrine that profits derived from the telegraph service were legitimate sources of revenue. "When," he said, "the revenue"—meaning, we suppose, the national revenue—"is in such a flourishing state that considerable sums were at the public disposal, the charge upon telegrams would come in just comparison with other claims upon the Exchequer." In other words when the Treasury can afford to forego the profit, such as it is, at present accruing from telegraph business they will consider the claims of the customer to a remission of charges. This to our thinking effectually disposes of the assumption that a tax upon telegrams in the form of a slightly excessive charge over prime cost is of itself necessarily inequitable or inexpedient.

The strongest arguments in favour of a reduced tariff were urged by the Postmaster-General, who, though unable at present to establish it, is evidently in favour of cheaper telegraphy. To Mr. Fawcett the fact that a telegram can be sent between the United Kingdom and Belgium, or France, for less money than from one part of London to another is a striking anomaly. No doubt it is; but the anomaly is not confined to this country, nor is it so illogical as it appears at first sight. The word rate and the message rate are two different things. For international telegraphy the former works satisfactorily, and rules very cheaply indeed in certain cases; but it is not a uniform rate in the ordinary meaning of the term, and so long as uniformity prevails for inland telegraphy, the international system will occasionally seem the cheaper. And this is as true of continental countries as of the United Kingdom. Neither is there anything so very outrageous in the

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relative charges of the two systems. In point of actual expense, as well as of labour incurred in the despatch of messages, Paris and Brussels are nearer to England than are some parts of London to its suburbs. The truth, however, is, all such comparisons are deceptive, and are capable of proving almost anything. In framing our inland tariff we are guided by financial expediency, and are not to be frightened by anomalies.

We can take no exception to Mr. Fawcett's calculations as to the prospective possibilities of reducing the tariff based upon the average growth of the receipts. The loss that would be sustained were the alteration to take place at once is, we think, rather under than overstated; and we certainly consider the estimated time necessary for recovery after a loss amounting to nearly half the present net revenue was far too short. The tendency would be to reduce the average charge per telegram to its minimum, namely 6d., especially if the promoters of the scheme are sincere in their professions of expecting to make the sixpenny rate popular. The average amount received now for each telegram is only a halfpenny in excess of the minimum rate. The authority on which the Postmaster-General has relied for his calculations estimates the average price paid for each telegram, with a ½d. per word rate, and a minimum charge of 6d., would amount to 10d. We should ourselves be inclined to estimate it rather at something under 8d. An average reduction of 2½d. per telegram would, we fear, satisfy nobody; and, unless the "lower and middle classes," of whom Mr. Fawcett spoke in such touching terms as being virtually prohibited from using the present tariff, came to the rescue of the new in a benevolent and liberal spirit, the estimated loss would be far greater than we are given to suppose. For our part we do not believe in the lower classes sending telegrams for sixpence, nor in the middle classes sending more for sixpence than they do now for a shilling. What we do believe is that people who use the telegraph now would use it more largely if the cost were reduced, and that they would take particular care to reduce the cost as far as possible. This, of course, means that the revenue, instead of falling less than 20 per cent., would drop by something over 30 per cent., and that the process of recovery would be proportionately delayed.

ELECTRICAL ACCUMULATORS OR SECONDARY BATTERIES.*

BY PROFESSOR OLIVER J. LODGE, D.SC.

No. IV.

(CONTINUED FROM PAGE 131.)

So far we have investigated the amount of chemical action in a Faure cell, when a given current is passed through it; but though this is important it is by no means all that we want to know, for the same chemical action exactly will go on in every cell through which the same current is driven, and the chemical work which a given current can do is, therefore, essentially unlimited. But, of course, the more cells we have in series, the more driving power—or electromotive force—do we require to send the current through them; and the chemical work that can be done by a given current generator is determined, therefore, by its available electromotive force and current strength conjointly. In this respect chemical work is precisely in the condition of every other form of work, and, in fact, it cannot be otherwise.

Consider now, as our source of current, a dynamo-machine driven with the horse-power P. Of this power some is wasted in friction and in churning the air; another portion is spent in warming the exciting magnets and armature, while the remainder, which we will call p, is available for maintaining the current through the external circuit. What fraction p is of P depends upon the perfection of the dynamo, and, indeed, the ratio $\frac{p}{P}$ may be called its efficiency. We may, perhaps, surmise that a probable value for this ratio is as much as $\frac{3}{4}$, but it is not likely to be more. To measure p we have only to masure the electromotive force in volts between the terminals of the dynamo and the currents in Ampères which it is at the same time producing in the whole outer circuit, multiply the two together and divide by 746. We will, therefore, take p as a known quantity.

Now take N Faure cells and arrange them, n in series and m abreast, so that they are equivalent to n cells, each m times the size of a single one. Of course $m\,n = N$. Let the resistance of each cell with its connecting wire be r ohms—the resistance of the leading cables need hardly be taken into account if they are thick enough to keep cool—then the resistance of the combination of cells is $\frac{n\,r}{m}$ ohms.

To drive a current of C Ampères through this resistance would require an electromotive force $\frac{n\,r}{m}$ C volts, which we may write $n\,r\,c$, if we put c for the current passing through each of the m series of cells. But this electromotive force is not enough to maintain the current for more than an instant; for directly the cells begin to charge they each exert an opposition force e, which must be overcome. This opposition e may or may not vary during charging, but it probably does not vary very much after the first hour or so, and it may be considered as not far off 2½ volts. It can be measured by connecting an electrometer to the terminals of a charged cell momentarily disconnected from the charging circuit. No time must be lost in taking this measure, or its value will diminish, and if the cell is short-circuited it falls off rapidly—probably because of the consumption of the hydrogen alloyed with the lead. It is its maximum value which is active in opposing the charging current, and this it is which we agree to call e in volts. The whole set of cells will offer an opposition force $n\,e$ volts.

If the cells are not uniform we must determine the *average* values of e and r, but there is every possible reason for turning out the cells from the manufactory as uniform as they can possibly be made, and afterwards keeping them uniform by subjecting them to precisely similar treatment. Hence the practice of replenishing the power of a working battery by occasionally adding an instalment of fresh cells is not to be approved on a large scale, unless it is carried on with regularity, a fresh one being put on at one end and a comparatively worn-out one simultaneously taken off at the other by some automatic time-keeper.

It is well known in ordinary voltaic batteries that if any of the cells are different from the others in any way, we get all the disadvantages which such difference may cause, and scarcely any of the advantages; in other words, one extra good cell in a series of poor ones is lost, and its effect swamped; while a single bad one among good ones chokes the lot. It is only like the links of a chain after all. Any difference—whether in size, or weight of lead, or closeness of plates, or time of charging, or of standing, or of discharging, or any temporary short circuiting of one cell more than of others—if it can produce harm it will, but if it tries to do good it can't. Hence every difference should be avoided.

Well, we were going to write down the E M F necessary to force the current C through each of the m series into which we have supposed our cells to be arranged while charging, and it is

$$E = n\,e + n\,r\,c$$

the first term overcomes the opposition electromotive forces, the second drives the current against the given resistance.

The whole energy expended per second is proportional to E and to the whole strength of current C, or $m\,c$, and is

$$E\,C = m\,n\,e\,c + m\,n\,r\,c^2$$

The first term represents the useful work done, or the

* We reprint these excellent articles from the *Engineer*.

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energy expended in overcoming chemical affinities, and in storing the current; or at least it represents this on the hypothesis that all the chemical substances decomposed assist the storage by being ready to recombine and drive the current back again whenever called upon to do so, and not before. If the cells are allowed to evolve gas while charging, or to stand a long time after charging, these conditions are not fulfilled, and some of the $m\,n\,e\,c$ is lost. Hence in saying that $m\,n\,e\,c$ represents the useful work, one means that it does so under the most favourable circumstances, or that it represents its maximum value.

The second term $m\,n\,r\,c^2$ is certainly all wasted and goes to warm the cells. The proportion between the waste and the useful is therefore $\frac{r\,c}{e}$; and this shows the great desirability of keeping the charging current c weak, as well as for having the cells large and of low resistance. The horse-power available as current we have supposed to be p, and $p = \frac{\text{E C}}{746}$; hence we may write the foregoing equation thus (remembering that $m\,n = \text{N}$):—

$$\text{N}\,c = \frac{746\,p}{e + r\,c}.$$

This represents the total amount of chemical action going on in all the cells put together, for the current c is passing through each, and chemical action proportional to c is going on in each, therefore the total chemical action is N c. Looking at what N c is equal to, we observe that p is fixed and e is beyond our control; so again we perceive that the only way of getting the most effect at the least cost is to keep $r\,e$ small. Now the resistance of a large Faure cell and connections need not exceed, I suppose, ·002 of an ohm, and the charging current sent through it may be kept as low as 4 or 5 Ampères if desired; hence, as the value of e is 2·5 about, it is quite possible to make $r\,c$ almost wholly negligible compared with e. We shall thus get out of the given horse-power the greatest amount of chemical action per second that we possibly can, viz.:—

$$\text{N}\,c = 746\,\frac{p}{e}$$
$$= 300\,p \text{ say.}$$

The equations of last week, expressing the amount of total decomposition on both sides of a Faure cell when a given current is passed through it, may be now modified to express the decomposition produced in a whole set of similar cells arranged economically and subjected to the utilised horse-power p for T hours, by simply writing in those equations 300 p T instead of C T.

As far as here appears, the number of cells does not signify, for if more cells are used less will be done in each, and conversely. But we have just seen how important it is to keep c small, that is, to charge with a very low strength of current; hence the more cells charged at once the better. It seems difficult to use too many. The limit in series is reached when $n\,e$ is nearly equal to the highest possible electromotive force of the shunt dynamo—that is, the number n must not exceed two-fifths of the maximum electromotive force available, expressed in volts. But it may be nearly as great as this with advantage. There seems no limit to m, the number of cells that may be joined up in multiple arc, and apparently the more the better. But the "lead" wires and the armature of the dynamo must be of very low resistance, or they will get heated if m is very large, even though c, the current through each set of cells, is small. Edison's bar armatures seem just the thing therefore, or some of those machines which are made for electro-plating purposes. The wire on the field magnets should be very long, so as to magnetise them strongly without shunting off too strong a current, even though it is driven with the highest available electromotive force.

The highest available electromotive force is the difference of potential between the terminals of the shunt dynamo when they are disconnected from the external circuit, so that the whole of the current produced in the armature passes through the field magnets. There must be some connection between the resistance of the wire on the field magnets, and on the armature, and the number of cells which will give the most economical result, though it is not a relation that is obvious to common sense; but it can no doubt be worked out if we set to it, and I will try next week. Meanwhile, let us put in a convenient practical form part of the result of this week's article, viz., that if the best arrangement is adopted in every way, no waste being allowed, and no secondary or useless chemical action permitted, the total amount of any substance of "atomic weight" w and atomicity k that can be decomposed or liberated, as the case may be, by p horse-power, utilised as current in any number of cells, each of maximum electromotive force e, is

$$\frac{746\,p}{e} \cdot \frac{w}{12000\,k} \text{ pounds per hour,}$$

which becomes for Faure cells, whose e is $2\frac{1}{2}$ volts

$$\frac{p}{40} \cdot \frac{w}{k} \text{ pounds per hour.}$$

For instance, 2·8 p pounds of lithage can be peroxidised, and also reduced, per hour, by the horse-power p applied to this purpose and to nothing else. Of minium the amounts are 2·1 p reduced, and 4·2 p peroxidised; that is, 6·3 p pounds of minium may be acted on altogether under the most favourable circumstances. Thus, if 5 horse-power are utilised as current, 31·5lb. may be acted on in an hour, or a ton in 71 hours. To form 120 cells, each containing 28lb. of minium properly distributed between the two plates, cannot take less than T hours, where $6{\cdot}3\,p\,\text{T} = 28 \times 120$; which for $p = 5$ gives T = 106. But if the cells contain 14lb. of minium on each plate they will take longer, viz., at the very least $\frac{100}{p}$ hours.

POSTAL TELEGRAPH TARIFFS.

In the House of Commons on Monday the question of a reduction in the rates charged by the Post Office for inland telegrams came up, and elicited an interesting statement from Mr. Fawcett, the Postmaster-General.

We give the report of the proceedings as it appeared in *The Times* of Tuesday last:—

"Dr. CAMERON called attention to the rates charged by the Post Office for the transmission of inland telegrams, and stated that the principles on which the charge for telegrams should be based were rightly explained by the Postmaster-General to be two. In the first place, any undercharge was to be deprecated, as involving the taxation of the community for the benefit of those persons who sent telegrams; and, secondly, any overcharge was to be avoided, as resulting in the taxation of the senders of telegrams for the benefit of the community. The earnings made by the postal telegraph system had gradually risen, until they amounted to £540,000 per annum, a sum sufficient not only to pay a 3 per cent. dividend on the capital employed, but also to provide a surplus of £220,000, representing a profit to the tax-paying community made at the expense of the senders of telegrams. It had been asserted that the adoption of a 6d. minimum charge for telegrams would lead to a loss to the Post Office of £167,000 per annum. But with a surplus revenue of £180,000 per annum the Post Office could afford to try the experiment, and he was satisfied that before long the increase in the number of telegrams would convert any loss that might be sustained by the reduction of charge into a profit. A tax upon telegrams was a tax upon commerce, and he, therefore, asked the House to pronounce that tax inexpedient. He begged to move that 'The working of the Postal Telegraph service with a view to the realisation of profit involved a tax upon the use of telegrams, that any such tax is inexpedient, and that the profit derived from the service is now such that the charge for inland telegrams should be reduced.'

"Mr. MONK had great pleasure in seconding the resolution. On several occasions within the past few months he had been in communication with the right hon. gentleman with regard to a reduction in the rate, not only of inland but also of foreign telegrams, and the replies of the right hon. gentleman had on the whole been of a very encouraging nature. The subject was one in which the various chambers of commerce throughout the country had taken a very great interest, and it was felt that a

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reduction in the cost of telegrams would be a very great boon to the commercial community. In these circumstances, he hoped that no great opposition would be offered by Her Majesty's Government to a proposal for an early reduction in the charge for telegrams, if not to 6d., at least to 9d.

"Mr. Fawcett would endeavour to deal very frankly with this very important question. He fully admitted that the arguments in favour of a reduction in the charge for telegrams were very strong. It was undoubtedly the case at the present time that under the international rates which had been lately settled, it was possible to send a telegram from any part of England to any part of Belgium, or from any part of the United Kingdom to any part of France at a less cost than was incurred in sending a telegraphic message from one part of London or of Liverpool to the other. The reason for that was that under the special rate agreed upon between England and Belgium telegraphic messages were sent at the rate of 2d. a word, and under that agreed upon between England and France they were sent at the rate of 2½d. a word. It was not unusual for a telegram sent under those scales to consist of an address of three words and a single word, such as 'better,' 'come,' or 'worse,' and such a message could be sent to Belgium for 8d. and to France for 10d. He was also free to confess that in view of the number of telegraph stations in the United Kingdom the number of messages sent was not as large as might have been expected. The number of telegrams sent each year was about 25,000,000. That gave a weekly average of about 480,000, and a daily average of about 80,000. Considering that there were 5,000 stations, he did not think that 80,000 was a large amount per day, and there was no other conclusion to arrive at than that the present 1s. charge was virtually prohibitory, not only to the working classes, but to many of the middle classes also. He hoped the House would think that he had stated the case in favour of a reduction in the price of telegrams clearly and unreservedly. He was further prepared to admit that if the price of telegrams were reduced there would probably be a large increase in the amount of business. But his hon. friend had thrown out a suggestion with which he could not quite agree. He contended that the reduction in price might be made in bits by reducing the price for local telegrams only. He thought, however, that it would be a most serious thing were they to infringe upon the principle which seemed to regulate the Post Office system—namely, uniformity of charge. In France, and, he believed in some other Continental countries, they had what were known as express telegrams —that was that, by paying an extra fee, the telegram had priority over ordinary ones. As regarded that system, he could only say that as long as he had the administration of the Post Office he would strenuously oppose its introduction. It would introduce an unfair partiality, and he thought that the system should be resisted as being a most undesirable one. While agreeing with much that had fallen from his hon. friend he could not accept his motion as it stood, because it was opposed to facts as they existed at the present time. He was prepared to say then, as he said when he received a deputation on the subject, that the question was worthy of the consideration of the Chancellor of the Exchequer whether telegrams were a desirable means of taxation. But his hon. friend had assumed that at the present time a profit was being made upon this service. It would be his painful duty to show that the conclusion at which his hon. friend had arrived was not applicable to the present state of things. His hon. friend said that the telegraph revenue calculated on commercial principles showed a regular growth since 1876 amounting to about £23,000 per annum, the total for the year 1880-81 being £440,000. His hon. friend concluded from that that the revenue for 1881-82 would be about £500,000. That would be so undoubtedly if the revenue continued to increase, but, unfortunately, a considerable decrease was anticipated during the present year owing to the following facts:—The House would remember how last Session he was pressed by hon. members on both sides to increase the pay of the telegraph *employés*. He had granted an increase to those *employés*, which had cost the Department about £80,000 per annum. That amount must, of course, be added to the cost of the telegraph service, and the effect would be that, instead of £512,000 revenue for this year, the revenue would probably not exceed £400,000. He was aware that complaints had been made by the telegraph *employés* that the increase accorded to them was very small and that it was worse than nothing. All he could say was that, if they considered a charge of £80,000 a year on the public funds worse than nothing, he deeply regretted having made a sacrifice of public money to them. His hon. friend had stated that the reduction to 6d. telegrams would, probably, cost the revenue about £170,000. Those were the figures he had previously given and he was prepared to abide by them. He would show the House how that sum was arrived at. The average amount now received from each telegram was 1s. 0½d. The cost was about 9d. The profit was thus about 3½d.; and 25,000,000 telegrams at 3½d. amounted to £364,000. The gentleman who was at the head of the telegraphic department of the Post Office had informed him that if telegrams were reduced to ½d. per word, with a minimum charge of 6d., each telegram would be charged on the average 10d. and the cost would be 8½d. A gentleman had calculated that there would, probably, be 30,000,000 of telegrams instead of 25,000,000. Each telegram would then bring a profit of 1½d., and the net revenue would be £187,000, showing a loss of £177,000. On the other hand, he was bound to admit that there were many high authorities who did not estimate that the loss would be so great as he had just said. But it was absolutely impossible to foresee what would be the result of sixpenny telegrams. It was well to remember that the greatest of all postal reforms—the introduction of the penny postage—was not at first a financial success. Experienced officials had carefully looked into the question and informed him that it was more than sixteen years after the introduction of the penny postage before the revenue reached its former amount. Great, therefore, as might be the after financial results, and the advantage conferred immediately upon the public, it by no means followed that loss would not be incurred by the adoption of such a reform as was advocated by his hon. friend. The result arrived at was that the revenue from inland messages would be reduced by £177,000. If the present net revenue was taken at £400,000, the future revenue would be £223,000. The capital expended in the telegraphic service was about ten and a half millions. Interest on that sum at 3 per cent. would be about £320,000. Thus, instead of the telegraph bringing large profits as his hon. friend had said, there would be a deficit of £100,000. Besides he had taken the interest at the lowest amount —3 per cent. But the result would be still less satisfactory if the interest were reckoned at 3¼ per cent. as it really ought to be reckoned. It was, however, desirable to state that although that would be the immediate financial result, he believed that with sixpenny telegrams the revenue would steadily improve. The head of the telegraph department had come to the conclusion that at the end of four years the revenue from the telegraph would have regained its present position. The question, therefore, to be considered by the Chancellor of the Exchequer, that House, and the country was whether for the sake of the great advantages which he believed would result to the community from the lowering of the price of telegrams, it was worth while to sacrifice for the first year £177,000, for the second year it might be £140,000, the third year perhaps £100,000, and at the end of the fourth year, perhaps nothing at all. He hoped he had stated the case clearly. It was often asked by the public Press and by Chambers of Commerce why the Postmaster-General did not introduce sixpenny telegrams. His answer was, 'Where is the money to come from?' On the other hand, he was often asked to raise the wages of telegraph *employés*. But he would ask hon. members to remember that they could not eat their cake and have it. He could only say that the best way for hon. members on both sides of the House to bring about sixpenny telegrams was to strengthen the hands of the Government in carrying out their policy of economy. As for himself, nothing would give him greater pleasure than to receive a message from the Chancellor of the Exchequer that the finances of the country were in a condition to admit of the change proposed.

"Mr. R. Martin hoped that the Government would take into account the important bearing upon the question of telephonic communication, which in large towns was tending to supersede the telegraph.

"Dr. Cameron said that he should go to a division on the question of the expediency of taxing the country for the purpose of reducing the price of telegrams.

"Mr. Gladstone thought that the statement of his right hon. friend was clear and ingenuous. His right hon. friend had shown no bias against the principle of reduction in the price of telegrams, and had, in fact, been liberal in the expression of a general opinion in favour of the views expressed in the motion. He did not know that he should be disposed to go quite so far as his right hon. friend upon the question of taxation for the benefit of the telegraph service. No doubt no remission of taxation had been more advantage to the public than remissions on the means of communication. When the revenue was in such a flourishing state that considerable sums were at the public disposal the charge upon telegrams would come in just comparison with other claims upon the Exchequer. Further than that he could not go at the present moment.

"Mr. J. Howard hoped the Postmaster-General would signalise his tenure of office by the introduction of sixpenny telegrams.

"The House divided, when the numbers were—

"For Dr. Cameron's resolution.................. 77
"Against it 148
"Majority .... —71"

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TELEGRAPH CLERKS' CONFERENCE.

The annual Conference of the Postal Telegraph Clerks' Association, established in December, 1881, was held at Anderton's Hotel, Fleet-street, on Saturday last, Mr. Mulholland, of Manchester, in the chair. Delegates were present from all parts of England, Ireland, and Scotland.

The CHAIRMAN having briefly opened the conference, Mr. Crighton (Liverpool) submitted the following resolution:—"1. On behalf and at the desire of the postal telegraph clerks of the United Kingdom, this conference expresses its strong dissatisfaction at the inadequacy of the scheme of revision last year applied to their department, as well as at the unjust and partial manner of the application of that scheme, and its indignation that, while that scheme ostensibly confers benefits, however small, those benefits are throughout the service to a large extent nullified by the system of classification which is still retained, and in several important offices quite or more than counterbalanced by such retention in conjunction with an extended system of divided attendance which deprives members of the staff of about four additional hours daily." Prior to the revision, the speaker said, public opinion was almost unanimous in their favour, and Mr. Fawcett had therefore found it necessary to attempt some kind of investigation. With reference to the scheme which was the result of this investigation, the speaker said that one of their principal complaints had been that the salaries of telegraph clerks of eight or nine years' service was not in accordance with their responsibility. To remedy this, Mr. Fawcett gave two or three men a weekly increase of 16s. 6d., and ignored the claims of the main body of telegraph clerks. Ten per cent. of them received substantial promotion; but would it not have been far better, as a matter of economy and prudence, if Mr. Fawcett had given an immediate rise of 5s. to 35. per cent. of their number, rather than the greater rise which had been given to 10 per cent. The telegraph clerk of seven years' experience was worth at least £75 per annum, with a prospective maximum of £200 a year. In many offices the old first class at 44s. had been abolished, and 36s. had been substituted, and men who were at the top of the old second class had received a shilling rise, and were debarred from further advance; but even this small concession was modified by the retention of classification. In reference to Sunday duty, too, the scheme was inadequate, and the night-duty arrangements were to be condemned. Physically, socially, and intellectually they were very injurious. It was impossible to make any arrangements for mental culture, and it was felt that there should be some reduction of the hours of work, and not merely a quarter of an hour one day and half an hour another. In every respect where the revision was made its advantages were neutralised by classification and the new system of promotion. The number of superior appointments in the telegraph departments was not so large as the postal departments in most of the large towns. For example, in Liverpool the number of postal clerks was 183, for which there were fifty-eight superior appointments; while the number of telegraph clerks was 198, with only twenty superior appointments. He urged that they should have a parliamentary inquiry, to which Mr. Fawcett, who had already admitted their claims by his revision, could have no possible ground of objection.

Mr. CLARKSON (Newcastle-on-Tyne) said the staff which he represented had publicly expressed their dissatisfaction with the arrangements of Mr. Fawcett, and with the manner in which they had been applied. They objected to the disparity in the number of superior appointments compared with the number in the postal department, and to the provisions with regard to holidays, in which a change had been promised, but which change it was now announced could not be effected.

Mr. DELAHUNTY (Dublin) held that the only way in which they could hope to obtain redress was to obtain a Select Committee in the House of Commons to inquire into their grievances.

Mr. HEALD (Manchester) said that Mr. Fawcett had evidently valued the labour of telegraph clerks from the standpoint which he took with regard to the sorters. In talking with Mr. Cowen, the member for Newcastle-on-Tyne, the previous day, that gentleman had remarked that he might be able to do sorter's work, but he certainly was not qualified to do the work of the telegraph clerk. In that opinion Mr. Cowen was correct.

Mr. ROBINSON (York) said that the only thing they could do was to obtain a Select Committee. Petitions were in his opinion a farce, and they must, through the Press, the public, and Parliament, endeavour to get their grievances ventilated before a committee of the House.

Other delegates spoke to the same effect in support of the motion.

Mr. MORRIS, the general secretary, said he regarded the scheme of revision as totally inadequate, an inadequacy which was aggravated by the mode of its application. The Playfair Commission was expressly appointed to inquire into the mode of promotion adopted in the Civil Service. That Commission expressly reported against classification, and the telegraph clerks thought it hardly fair that in face of that report the postal authorities should retain the system of classification with regard to the services over which they had control. Classification, which meant that an expert of the second class should receive considerably less wages than a man in the first, who was not so facile at his business, and who must wait if he wanted promotion until a vacancy occurred in the first class, was in itself an evil, besides which the fact that the increases were small tended to aggravate the dissatisfaction with which classification was regarded. Combination had done something for them in the past, and it might be depended upon to do something for them in the future. All they asked for was impartial inquiry, and he believed that another year would enable them to congratulate themselves on having achieved a further improvement of their position.

Mr. HASLAM (Birmingham) raised an objection to the word "nullified" in the resolution, and it was accordingly modified as follows:—that "benefits would be to a large extent diminished."

The resolution as amended was then carried unanimously.

Mr. SCOTT (Liverpool) moved, "That the great pressure of public business in the House of Commons having rendered it impossible for Mr. Macliver to introduce his motion for the appointment of a Select Committee to inquire into the grievances of the telegraph clerks, this Conference, while heartily thanking him for his past efforts on their behalf, earnestly hopes that he will avail himself of the first favourable opportunity of taking the opinion of the House upon the subject."

Mr. BRIGHTON (Bristol) seconded the resolution, which was supported by other delegates.

Mr. LUCAS (Leicester) thought that it would be well to issue a circular which would put members in possession of the whole of the facts. At present members of Parliament had an insufficient knowledge of what were really their grievances.

Mr. HASLAM (Birmingham) fully agreed with the last-named delegate, and suggested that it would be an advantage if they made use of local political organisations. Of course, he granted that there was nothing political about their movement, but what he wanted was, that in their various districts they should endeavour to lend weight to their representations to members of Parliament by bringing in the aid of local political organisation wherever it could be obtained. There was one point on which he wished to lay stress, and he hoped the experience he had was common to them all. The Birmingham postmaster took a kindly interest in all his subordinates, and was really anxious to better their condition; but while he did not object to their meeting and discussing their grievances, he certainly did object to their putting their grievances before the local public through the Press, and thus committing a breach of that official discipline which was necessary to the good order and government of any public institution such as theirs, with its grave responsibilities. In conclusion, he hoped that they all would be loyal, while respectful and obedient, in the support of their claims—claims which he believed would be more in the public benefit than of the telegraph clerks themselves.

The resolution was then adopted in a somewhat modified form as follows:—"That this conference, being of opinion that an inquiry by a Select Committee of the House of Commons into the administration of the telegraph department is necessary in the best interests of the service, earnestly thanks Mr. Macliver, M.P., for his past efforts on their behalf, and hopes that he will avail himself of the first opportunity to take the opinion of the House upon the subject."

Mr. CLARKSON (Newcastle) then brought under consideration the propriety of taking before the law courts a test case by which to decide whether, under the Telegraphs Act (1868), pre-transfer clerks should be conceded the rights and privileges of clerks in the permanent Civil Service of the Crown.

After some discussion the following resolution was carried unanimously:—"That the pre-transfer clerks be recommended to memorialise the Postmaster-General, praying that they be conceded the rights and privileges of clerks in the permanent Civil Service of the Crown; and that, pending the decision of the Postmaster-General, further consideration as to legal action be referred to the central committee."

The attention of those present was then directed to the private affairs of their association, suggestions being put forward that they should register themselves as a friendly society, or trades union. The balance-sheet of the association, though it is but six months old, shows a balance of over £610.

THE MAGAZINES.—The *Nineteenth Century* for July contains an article on "Electric Light and Force," by the Right Hon. Viscount Bury.

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LEGAL.

LONDON AND GLOBE TELEPHONE COMPANY v. UNITED TELEPHONE COMPANY.

This case came before Mr. Justice Fry in the Chancery Division of the High Court of Justice on Thursday week. The plaintiffs are the assignees of Hunnings's patent transmitter. The defendants are the assignees of both Bell and Edison's patents for telephones in this country. This was a motion to restrain the defendants from continuing the publication of printed statements in the nature of a libel on the plaintiffs' patents. The statements complained of were parts of a notice printed on the inside of the cover of a pamphlet entitled "The United Telephone Company (Limited) list of subscribers to the Exchange system," and were in the following terms:—

"The United Telephone Company have been advised by eminent counsel that all forms of transmitters in which carbon is used in a free or powdered form—as, for instance, in the transmitters usually known as Moseley or Hunnings—and that all the so-called microphone transmitters, including those known as the Crossley and the Gower-Bell, are infringements of Mr. Edison's patent as amended by disclaimer." And "No form of magneto telephone, and no form of transmitter in which carbon or other equivalent substance is employed, whether known as Edison's, Moseley's, Hunnings's, Crossley's, Gower's, or any other name, can be manufactured, sold, supplied, or used in this country except under license from the United Telephone Company (Limited). Proceedings will be taken against persons infringing the company's patents and other rights as above set forth."

It will be remembered that in the recent case of the United Telephone Company *v.* Harrison, Cox, Walker, and Co., the plaintiffs, amongst other things, sought to restrain the defendants from making or selling Hunnings's transmitter, alleging that it was an infringement of Edison's patent. In his judgment, however, Mr. Justice Fry held that Edison's patent was void because he had claimed in the complete specification the phonograph, an instrument which Mr. Justice Fry did not consider to have been foreshadowed in a proper manner in the provisional specification.

It appeared from the evidence in the present case that, on the solicitor to the London and Globe Company complaining of the issue of the printed statement subsequent to the above-mentioned trial, the solicitors of the United Telephone Company had written to say that they had advised the defendants that the statements must be altered in accordance with the position of matters; that amended statements would appear in the next issue of the list of subscribers; and that in the meanwhile any copies in hand would not be sent out. Notwithstanding that undertaking, some copies were delivered to the persons who made inquiries at the United Telephone Company's offices, and this action was commenced.

The defendants put in evidence that the copies had been delivered without the knowledge and against the intention of the higher officials, that the remaining copies had since been locked up, and they would issue no more. Nevertheless, they defended the motion; in the first place,on the ground that there was no evidence of any damage to the plaintiffs having resulted from their negligence. In the next place, it was argued on their behalf that the statements were really matters of opinion, which they had a right to state, for the decision was under appeal, and that Lord Maclaren had, in an action brought in Scotland, upheld Edison's patent.

In giving judgment, Mr. Justice Fry said:—The questions which I have to determine in the present case are two. In the first place—Are the defendants acting honestly in insisting upon their right to issue the notice complained of? and, in the second place—Have the plaintiffs satisfied me that they are sustaining any injury from the publication of this notice?

The facts are these. The defendant company issued a notice in this form—"No form of magneto telephone, and no form of transmitter, in which carbon or any other equivalent substance is employed, whether known as Edison's, Moseley's, Hunnings's, Crossley's, Gower's, or by any other name, can be manufactured, sold, supplied, or used in this country, except under license from the United Telephone Company (Limited). Proceedings will be taken against persons infringing the company's patent and other rights as above set forth." I determined in the action which was before me that Hunnings's patent could be manufactured, sold, supplied, and used in this country without a license from the United Telephone Company. I, therefore, rightly or wrongly, determined the very opposite of the proposition which the defendants put forward. I am perfectly alive to the very great probability that my decision may be wrong. I know it is at variance with the decision of an eminent judge in Scotland; but, however great my sense of doubt may be as to the ultimate decision of the case, I must bear in mind that I am a competent judge to decide a case, and as long as my decision stands I am bound to act upon it, just in the same way as I should feel myself bound to act on the decision of any judge sitting in any of the other courts of this country. I cannot, on any grounds of modesty, refuse to act upon my own decision. That being so, I take it, the defendants are now alleging the very opposite of that which a competent court has decided to be the case. It is suggested that they are doing this *bonâ fide.* Now, how stands the matter as to *bonâ fides*?

In May, the present plaintiffs complained of the circular, and the solicitors of the defendants, Messrs. Waterhouse and Winterbotham, informed the plaintiffs' solicitor—"Immediately after the decision of Mr. Justice Fry, we informed the secretary that it would be necessary to make alterations in the notice respecting infringements in accordance with the present position of matters, and these amended statements will appear in the next issue. In the meantime any copies of the existing list which remain in the company's hands will not be sent out." Nothing could be more straightforward or proper on their part. They gave the very best advice to the company. They advised the company not merely that it was expedient, but that it was necessary that the notice should be altered, and they gave what was equivalent to an undertaking that no further lists should be sent out. Unfortunately, the company have not only not kept that undertaking, but they have issued, subsequent to the letter, a circular containing the obnoxious paragraph, and the company have also thought fit to assert their right to do so. They issue that, after the advice of their solicitors that an alteration was necessary, and after the fact that that advice which had been tendered to the company had been made known to the persons whose interests were affected by it. To have issued that, with knowledge of the necessity of an alteration, was not, in my opinion, right, and I do not believe that the Company ever intended to do it. If it had not been for the justification that there may have been a slip, there would have been really no case. However, they choose to assert their right, notwithstanding the advice of their solicitors that an alteration was necessary. I am bound to say that I do not think the statement is one which an honest man would ever make. I do not think that an honest man would desire, without speaking subject to a condition, or referring to the decision of the Court, to say in an unqualified manner that that which a competent Court has decided to be false is true. If, notwithstanding my decision, they had stated their opinion as to the superiority of the decision of Lord McLaren to that of mine, or if they had in any way indicated that a Court of competent jurisdiction had decided contrary to what I had decided, no objection could be taken. I repeat the unqualified setting forth of a proposition which a competent Court has determined to be false, and which affects the interest of a third person, is not, in my judgment, a statement which an honest man would make, still less could it be made honestly after they had been advised by competent solicitors that the statement must be altered. I come, therefore, to the conclusion that the company are not honestly asserting their right when they assert a right to retain this paragraph. The next question is this, have the plaintiffs shown that their pecuniary interest and their rights are likely in all probability to be affected by the statement so set out by the defendants? It appears that the plaintiff company are the assigns of the other plaintiffs, Messrs. Ormes and Eldred. It appeared that Messrs. Ormes and Eldred have ever since June, 1881, been the assigns of Mr. Hunnings's patent. It appears that, in consequence of similar statements, their royalties have been brought down to zero, and I cannot for a moment doubt that what has had an effect in the time past will have the same effect in the time to come, and that if those statements are allowed to go forth, the interest of the plaintiffs in the patent will be injuriously affected. It appears that whereas before the statements were made a large trade was done by the licensees of Messrs. Ormes and Eldred, that business has greatly dwindled away. I think, therefore, the plaintiffs have shown that they have a pecuniary interest which is liable to be affected and injured by the statements made in the notice.

The result will be that I must grant an injunction, the terms of which will require a little consideration. It appears to me that I must restrain the defendants from setting out the paragraph which I have read, and from making any other statement that Hunnings's transmitter can not be manufactured, sold, supplied, or used in this country except under the license of the defendant company without reference to my decision; that is to say, I do not restrain them from saying that, provided they inform the public at the same time that I have decided the contrary. They are not to make the statement unless they qualify it by a reference to my decision, so long as that decision remains unreversed. There will be an injunction until the trial or further order.

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PHYSICAL SOCIETY.—June 24.

Professor Clifton, President, in the Chair.

New members: Professor Bartholemew Price, Principal Viriamu Jones.

Professor G. Carey Foster moved a vote of thanks to Professor Clifton for the excellent reception accorded to the Physical Society at Oxford on the preceding Saturday, and drew attention to the high efficiency of the Clarendon Laboratory, and the admirable provision made for the teaching of physics at Oxford.

Professor W. G. Adams seconded the motion, and endorsed Professor Foster's views of the position of physical science on the Isis.

Professor Clifton, in response to the vote, stated that the University of Oxford had liberally supported him in organising the Clarendon Laboratory, giving him all the funds he required, and showing a laudable desire to put physical teaching on the best possible footing in Oxford.

Professor C. A. Bjerknes, of Christiania, was then introduced to the meeting, and assisted by his son, delivered a lecture on "Hydro-Dynamic Analogies to the Phenomena of Electricity and Magnetism," which was illustrated by experiments and projections on the screen. Professor Bjerknes has been engaged in tracing these analogies for the last twenty-five years—at first mathematically, but latterly by experiments in verification of the deductions from his formula. These experiments were shown in the Paris Electrical Exhibition last year, and have been publised repeatedly in this country. Dr. Bjerknes has, however, advanced beyond the results there shown. These were chiefly confined to illustrating the static attractions and repulsions of electricity and magnetism, but he has now taken up the subject of electro-dynamic attractions and repulsions. The former effects are shown by brass balls oscillating, or by small tambours pulsating, near each other in water. These motions are communicated to the balls and drums by pulses of air transmitted from an ingenious air pump or bellows along india rubber tubes. A pulsating drum corresponds to a magnetic pole, an oscillating body to a magnet. When two tambours are vibrating near each other in like phase they attract; when in unlike phase they repel each other. The same holds true of the oscillating balls. The stream lines round these bodies correspond to the lines of force round magnets. All the phenomena of magnetic forces were illustrated in this way by Professor Bjerknes, including diamagnetism. The more novel part of the experiments consisted in representing the attraction between two electric currents flowing in the same direction by means of two cylinders about 5in. long and 1in. in diameter, oscillating round their longitudinal axes at close quarters in the water. The cylinders were oscillated by means of a pulsating tambour which communicated its motion to them by a tooth gearing on their ends. Attraction resulted when the oscillations of the cylinders were opposed to each other, and repulsion when they were in the same direction. This is an inversion of what might have been expected to take place after the theory of Ampère. A square of four oscillating cylinders was also formed, and a fifth cylinder oscillated inside it, the attraction or repulsion exerted on the latter being observed. A hydrodynamic galvanometer was made by placing an oscillating ball (which corresponds to a magnet) beside an oscillating cylinder, the result being a deflection of the ball, according to the direction of the oscillation of the cylinder. The experiments were witnessed by a full meeting, which accorded a hearty vote of thanks to Dr. Bjerknes.

A paper by Dr. C. R. Alder Wright, F.R.S., was taken as read. It was on "The Determination of Chemical Affinity in terms of Electromotive Force" (Part 6), and on the relations between the E.M.F. in cells constructed like Daniell's cell but containing different metals, and the chemical affinities involved in their actions. The cells employed were constructed of cadmium and copper and their sulphates, zinc and cadmium and their sulphates, zinc and silver and their sulphates, cadmium and silver and their sulphates, copper and silver and their sulphates. In all cases the sulphate solutions were of equal molecular strength. The general result is that the effect of a given alteration in the character of the plates opposed to cadmium or silver was found to be practically identical with that of the same alteration in the case of a Daniell cell. Volta's law of the summation of E.M. forces sensibly holds true in the cases examined. These cells also behave like a Daniell under variations of current density. see p. 244

The Society meets again in November.

New Cable.—The Eastern Telegraph Company have obtained a firman from the Sultan of Turkey authorising it to lay down a submarine cable between Malta and Tripoli.

ELECTRIC LIGHT AND POWER GENERATOR COMPANY (LIMITED).

The ordinary general meeting of the members of this Company was held on the 27th June at the City Terminus Hotel, under the presidency of Admiral Sir Edward Augustus Inglefield, C.B., F.R.S.

The Secretary (Mr. F. H. Landon) having read the notice convening the meeting, the report of the directors was taken as read.

The Chairman: Gentlemen, before asking you to adopt that report it is my duty to give you a short history of the Company—in fact, to account to you for what we have done since the time of the formation of the Company as far back as April, 1881. Now, companies I need not inform you are usually established with the view of working some patents or some special industry. There may be bad unremunerative patents and good management, but, on the other hand, there may be valuable patents and bad managers. In both such cases the work might be unremunerative. It may also be possible to have good patents and good management, and at the same time, from various causes, the working may be unremunerative. That is the position I wish to place before you to-day, so far as the past is concerned, and to point out the excellence of our patents, that our business is an exceedingly good one, and that we have done our utmost to make it remunerative. To make the case clear I will briefly epitomise our action since the commencement of our work, when we were formed to work the Lontin patent, and took over the concession given to us by the City authorities for lighting a portion of the City. We took this over and undertook, as speedily as possible, to enter upon it, though it was to have been started on the 1st of the following May. We commenced literally without having a staff, works, workshops, tools, cables, or any of the appliances that were necessary. We experienced the greatest difficulty in finding a site for our workshops. One or two places were offered, but we found them unsuitable. At last we found a position on the other side of Southwark Bridge, and supplied ourselves with tools, cables, and everything that was necessary. We had all sorts of drawbacks afterwards. We found on the first night that we were to begin the lighting that one of our cables had been seriously damaged by an accident of the workmen or from some other cause, and we had to replace that cable. We then found that there was a difficulty the next night owing to the want of water. The water had been cut off, and it was impossible to get water to start our engines. We then sank a well and started again, but we found that the neighbours objected to the working of the engine on account of the position of the shafting. All these were drawbacks to our proceeding in earnest with the lighting of the City. Time went on, the nights were getting longer, and it was very necessary that we should make a start before the nights got too long for working properly. At this point of our progress we had offered to us an incandescent lamp, the Company at the time of its formation having none. That lamp is well known as the Maxim. Now that lamp was exhibited in various places in London, and the result not only of our own evidence, but of all the evidence we could obtain, was that we bought it. Our electrician, Mr. Crookes, advised us on no account to lose the chance of obtaining that particular lamp. The price asked was very large—£100,000. Nevertheless, we felt that if it were possible to obtain it we must make a stretch and do so. After some little negotiation between the seller and ourselves we succeeded in bringing the price down to £54,500, of which £22,500 was to be in shares, and £32,000 in cash. We completed this agreement, and found ourselves then possessed not only of a very excellent incandescent lamp, but part of the terms of purchase was that we should also buy the Weston arc lamp. It was necessary that we should take this over with a number of patents connected with other purchases, and that we might lose no time we immediately made arrangements for having lamps and apparatus sent over to us from America. The trial we made between the Lontin and the Weston light decided the directors that the Weston was the more suitable for putting up in the City. We therefore had a number of them imported and put in position. The nights had now become so long that it was necessary to renew the carbons, which were supposed to burn for eight hours, so as to complete the whole period of darkness. It was, however, found very dangerous to the workmen while the current was passing from the lamp to shift the carbons. It was so dangerous to do so that the directors decided to stop the City lighting until we could obtain a double arc lamp such as is now burning in Queen Victoria-street. These double lamps took us some time to get from abroad. We thought, however, that we could make them, and we have done so, as well as having imported a sufficient number not only to light the City portion we contracted for, but to continue it very successfully. It was by this particular process that the Lontin was superseded by the Weston light. I mentioned to you that we had a difficulty with the cables, and we have a defective cable now. I may say here that our City lighting is not only satisfactory, but is now being worked at a certain advantage in a pecuniary point of view—nothing very large, but still it is being worked remuneratively. Now, your directors have not lost sight of the advantage which has accrued to other companies by selling concessions. We have been continually trying to do what others have done, and so successfully—to sell our patents, to have them worked in various places in the United Kingdom. We have not at present to report to you any great accession of wealth to our coffers by such sales, but at this moment we have three or four in progress, and I think I may say that something like £60,000 may be netted to the Company in a short time with reference to these concessions. We have met with great difficulty in dealing with contracts—there has been so much competition. There are now 54 electric lighting companies advertised, and though we were sixth on the list, yet still there has been so much competition that we have had great difficulty in being able to obtain remunerative work. I may give you an instance of the thing that occurs. A certain place of, I may say, public resort in London, not far from here, was proposed to be lighted by the electric light. Our manager was put in communication with the manager of that company, and the first inquiry was how much would be given as a bonus to the people connected with that institution if they gave us the light? That is not a single case. There are many cases in which we have been told that we must give something in the same way as a bonus. They appear to say—"It is not a question whether the light is good or bad. We want something for ourselves if we

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give you this job." We have, therefore, from that cause found great difficulty in obtaining orders. I have a list here of no fewer than 152 estimates we have sent out to various companies, firms, and institutions. Some may come in yet, but we know that a great many of those who made applications to us carried away from our office the price we estimated for and took it to some other company, which for a smaller sum got the work. We have made it a rule not to do more than a certain amount of advertising. We have done a certain amount of *bonâ fide* paying work. I will read it. First there is the City lighting, all of which is done from our works on the other side of Southwark Bridge. We have also three stations on the Metropolitan Railway lighted with the Weston lamp. Her Majesty's ships the "Agamemnon" and the "Polyphemus" are supplied by us with the incandescent lamp. The Edinburgh Post Office has been lighted by us very successfully for a considerable time. The *Western Mail* offices are lighted with our light. Maples, the great furnishers, have had some of our arc lights for eight or nine months. At Liverpool, the Prince of Wales's Theatre is lighted; in addition to which I may state that we have supplied our light to Messrs. Cash, of Coventry; Messrs. Brown, of Wigan; Messrs. Duff and Rowntree, Durham; the Risca Colliery, the Glasgow Fine Art Gallery, the Norwich Free Library, Messrs. T. and E. Hall, Dartford. At Windsor Castle our light was selected from others for lighting the courtyard, in connection with the Royal marriage. A few nights ago, too, our light was specially selected by a Royal personage, who would have no other, for the particular occasion of a *fête* at the Botanical Gardens. I was present, and the light was very much admired. I should like to mention one fact, which later on you must deal with. The Maxim lamp might belong to us or any other company. We are called the Electric Light and Power Generator Company, and that title is now so common that it has become difficult to connect our Company with the lights we possess, and therefore we propose to make a change in the name of the Company to overcome that difficulty. Although we cannot show any long list of places where our light is used, we have had numerous proposals as to future operations. We have concluded a contract for lighting Pentonville. One of the difficulties in connection with the contract was getting a piece of ground to put our engine on. Through Colonel Penton we have now got that facility. We propose to light Pentonville with the incandescent light in the ordinary street lamps. That will be very much cheaper than having to put up new lamps, such as those we have erected in the City. There is another place we are tendering for, but as to that the metropolitan authorities have not yet decided. The question of forming branch companies has been thought of by the directors, and they have not been idle in trying to get promoters of companies to take concessions of our patents. We have certain transactions now which may benefit us in the round sum of about £60,000. We are in treaty for concessions for two large districts—one abroad, that is Australia, and the other in the northern part of England. Perhaps it would be right for me now to allude to a question, which is very often put to me—How comes it that an officer of your Company—that your consulting electrician, who is an officer of the Company and a salaried officer—has lately become a director on the board of a new company, and has, we understand, sold an invention of his to that company when we know that all his inventions were offered first to your Company. I think this is a very proper time for me to explain to you that as far back as when the Maxim patent was offered to us Mr. Crookes informed us that he had a lamp which he would shortly perfect, and of which this Company should have the refusal. It might be asked, why did you want it when you had the Maxim lamp? The answer is, we had an economical working in the Maxim lamp—to fifty lights. We know that with the Swan and some other incandescent lamps their great advantage is that they can subdivide their lights in connection with other lamps varying from 10 to 15 and to 20 candle-power. It was very important that we should obtain, if possible, an incandescent light of comparatively small candle-power. We, therefore, entertained Mr. Crookes's proposal. I and several of the directors went to his house and saw the experiments, and were very favourably disposed towards accepting his lamp and purchasing the patent. When the time came for us to acquire it the question arose how far this lamp, which burnt well, had durability—that is, the length of time it could remain burning without being destroyed. It was necessary that we should have a certain number to experiment on. Mr. Crookes's laboratory did not admit of our making these experiments, and in the meantime we thought it right to protect ourselves and the shareholders before purchasing another incandescent light to refer to certain professional experts (of opinion foreign to ourselves) as to whether the light Mr. Crookes brought forward was one we should purchase and that would be beneficial to the Company. Two professional gentlemen who are well known in the scientific world, and another gentleman whose name is associated with the electric light formed a committee, and, after receiving their report, we decided it would only be prudent for us to defer purchasing that lamp till we could have a positive report from our manager as to its durability. Now, as these lamps could not be produced in sufficient numbers to test them for a sufficient length of time, the transaction fell through, and, as Mr. Crookes informed us that his lamp was one that was sought for in the market, and that he had had better offers than that which we made, we were obliged to request that if he were in treaty with other companies he would not attend at our board meetings except on special occasions. Shortly after we not only heard that Mr. Crookes's lamp was to be sold to another company, but he disposed of his interest in this Company, and that affected us prejudicially. I think this explanation is necessary, because some damage has been done to the Company. Meantime, however, we have been made independent of any smaller candle-power by having the means of making ten and twenty candle Maxim incandescent lights. We have seen lately an advertisement in the papers to the effect that Mr. Crookes's lamp had been bought for a large sum, and as Mr. Crookes has become a director of that company we have been daily expecting to receive his resignation, as we feel that it is impossible for him to serve two masters—one company with one incandescent lamp, and another company with a different incandescent lamp.

A Shareholder: Does Mr. Crookes receive a salary?

The Chairman: He receives a salary of £600 a year.

The Shareholder: Cannot he be called on to resign?

The Chairman: We leave that to his good taste. He is engaged to us for two years. Only one year of that period has elapsed, but at the end of the other year we could at once dispense with his services. As to what we have done with our Maxim lamp, it has been frequently used at banquets at the Crystal Palace and in various other places. It has such a good name in the market that the Jablochkoff Company applied for a concession for its use, and we made these favourable terms—that while they would employ no other incandescent lamp but ours they would let us sell concessions to other companies. Therefore, they are bound to the Maxim incandescent lamp and none other, while we can dispose of our concessions in places where the Jablochkoff Company may be working. We have also sold the Maxim lamp to another company on very favourable terms—the Railway and Electric Lighting Company. We have at present before us several proposals for street and shop lighting in various cities; but I think it is no news to you to hear that every one is waiting to see if something better will turn up. We hear of other companies working very successfully, but if most of those who are actually working were analysed it would be found in a great many cases that they were purely advertisement works—works which, if we had a large capital at our command, we might have done ourselves. I may, I think, now tell you what we have done in the way of advertising. We felt it was necessary that our lamps should be seen, not only by men engaged in the City, but by people requiring it in their country places, and places at the west end. We have been in great measure tied for want of a larger capital at our back, and for that reason our exhibition at the Crystal Palace was not so grand as those of other companies. We only had one engine there, while other companies had eight or ten. We think, however, that we are now beginning to reap the fruits of our working. We have exhibited our light at various places (which he mentioned). There are several other places where our lamps have been lent for exhibition. I have not enumerated them here, but still they have been seen, and I think we are now deriving some benefit from the time that has been spent, and which some of you, I know, believe has been spent without much benefit to you as shareholders. I have now given you a slight history of our past, and I think I should now shadow forth something of our plans for the future. We have now good manufacturing premises on the other side of the river. Those premises were originally put up for the purpose of the arc lamp. We have never tried to make dynamo machines, we find we can buy those as cheaply, but we have very good manufacturing premises for the arc lamp. We have also established a manufactory for making the incandescent lamp. We have now over 10,000 in store, and a number of arc lamps in construction. I may also say that Mr. Maxim has been over to this country. He is a man full of intelligence, and, perhaps, as clever an engineer as can be found in the world, and he has offered his services to the Company. At the present moment we did not feel justified in accepting them, for he is a gentleman who requires a very large salary. The company he is connected with in America has allowed him to offer his services to this Company. He is now in France, and requires to return to America, but he has placed himself at our disposal, and we have the refusal of his services for six months to come. We are therefore not obliged to engage his services at present, but in the meantime we have all the benefit of his advice. We propose, if the opportunity occurs, to establish small local companies with or without concessions. But we think, if we can get small companies who will take up our systems of lighting and pay us a royalty for the use of our patents, that will be very profitable. When I say that we have 1,200 shareholders on our list I think some of you might assist us in letting it be known among your friends that we possess the best arc lamp, and certainly the best incandescent lamp in the market. If you help us in that way you will strengthen our hands and assist your own pockets. We are, as I have told you, in negotiation for selling a concession in Australia for a very large amount, and also a concession for the north of England. We are also negotiating in connection with some very valuable contracts which will be very paying, and yield large profits to the Company, which is what we are looking forward to very anxiously. I think I have now put before you generally our history in the past, and what we hope from the future. I shall, therefore, conclude by asking you to adopt the accounts and balance-sheet already issued to you.

Sir Herbert Bruce Sandford: I beg to second the adoption of the accounts and balance-sheet as already issued to the shareholders. Our chairman's very exhaustive speech has covered the ground so thoroughly that there is scarcely anything in the accounts which is not mentioned in his speech. There is, however, one item as to which I think a few words may be interesting—the parliamentary expenses. That brings us to the association of the electric companies, which was formed chiefly through the general movement of this Company. The directors felt last autumn that it would be very desirable that the leading electric companies, while entering into competition as keenly as they chose with each other, should unite with each other in forwarding the interests which all had in common. We were joined very favourably in this idea by the leading companies. We met together, and do so once a month, and one of our first arrangements was to get by every possible means parliamentary powers to take up streets in various cities and towns where corporations or individuals wished us to do so. We found that very few corporations had the power to grant us those powers. At Glasgow, for instance, the gas company had such power that the corporation could not allow the streets to be taken up. We pushed forward our Bill at considerable expense, though at much less expense than if we had not had our association. The Board of Trade, seeing the general desire for such powers, took up the matter, and stated that if it had not been for the course we took in that respect their hands would not have been so strong in going before Parliament. The special committee has reported on the Bill, and if other troubles in Parliament will allow of it we hope to have the Bill passed in July. That will relieve us from a very great difficulty in getting contracts given to us by those who wish their houses and public buildings illuminated by electricity.

Mr. Storey referred to the large sum paid for patents, the number of patents in existence, and the possibility of litigation. He suggested that the chairman should inform them whether their patents had been handed over to them guaranteed free from litigation. If so what security had been taken to ensure that, and, finally, he should like to know in what position the Company would find themselves in in case decisions should be given against them.

Mr. Wheeler thought it advisable that the meeting should express some opinion with reference to Mr. Crookes's position—an opinion as to the expediency of his retiring from the Company. Such an expression of opinion would probably help that gentleman to make up his mind more quickly.

Mr. Crookes: May I be allowed to say a few words, not being a share-

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holder? In the first place I may say that I have listened with very great pleasure to the account the chairman has given to you of the very favourable prospects of the Company. No one has heard that with greater pleasure than I. I look on this Company as almost one of my children. It was thought of by me—or the Company embracing the principal object this Company was formed to work out—four or five years ago, and I have been in constant communication with Mr. Harding since then. I may say that the original prospectus was drawn up in my library, and the directors were selected by myself and friends before it came before the public. I have watched the Company from the very commencement, and have done all I could to forward the interests of the Company, and nothing has given me greater pleasure than in hearing the chairman say its prospects are so good, as to which I feel that the shareholders are to be congratulated. It so happens that I have been connected with electric lighting for a great many years. I have been experimenting in my laboratory, and I felt that when electric lighting was coming to the front I ought in justice to myself to put into force a great many discoveries I had made in scientific matters relating to the electric light. Before this Company was formed it was mentioned that I had an incandescent lamp. It was not perfect then, but sufficiently advanced for me to foreshadow what it would be. In the first prospectus submitted my name appeared as one of the directors, but that was left out at my own request because it was understood that the Company would have to purchase my lamps. Since then I have been consulting electrician to the Company and given them advice. At first I attended the board meetings regularly at the request of the board, or by right as one of the committee of the council of reference. However, that does not matter. Constantly, from that time till a few months ago, the subject of lamps and my patents came up. I was one of the jury at Paris examining the incandescent lamps. I saw exactly what one was worth and what another was worth. Naturally, without saying anything in favour of my own, I know what my own incandescent lamp is worth. There was, some time since, a great *furore* in connection with electric lighting companies, and patentees could get whatever they asked for their patents. In fact, it got into six figures. I, however, adhered to the offer I made to the Company, which was a very moderate one. I said, "Pay my expenses" (which had been very heavy), "give me so many shares and a small royalty or per centage on the sale of the lamps." During that time I was, I will not say bothered, but I was asked by a great many people about my lamp. I, however, kept the negotiations going on with the company until the *furore* went over. I ran the chance of losing the market for my lamp. I think the chairman has given you—with a little natural colour, which must distinguish anything that comes from that side of the table on a matter of that sort—a fair explanation. The thing went through because I declined to have my lamps put to a test which I knew they could not be put to. There was no apparatus for the purpose. The chairman says he is surprised I have not resigned my seat at the board. I suppose that was a slip, for I am not a member of the board. I am the consulting electrician of the company for two years. But I am tied to the company; I cannot get out of it. I am ready if I can. At the start it was thought that these arrangements should be made with me, and I said I had no objection to it. I should however be very glad, if it is the wish of the meeting, to give up that position [hear, hear]. I should be happy to bow to the wish of the meeting. The work I have had to do has been very little lately—some patents to report on. If there had been the slightest wish on the part of the shareholders to release me from my engagement, I should have been ready to fall in with their wishes. As far as selling my shares is concerned I was quite within my own rights in doing so. I bought them with my own money, and sold them when it was convenient to myself to do so. I simply exercised my right to sell them, but I may feel inclined after the glowing account which has been given by the chairman to go in and buy. If anything arises in the discussion I shall be happy to give any explanation.

The CHAIRMAN: I am very glad to answer the last speaker's question first. Mr. Crookes has given me credit for straightforward speaking as to the transactions between the Company and himself. The directors have had many times under consideration the question of asking Mr. Crookes whether he would resign, but we always ended by thinking that it would be better to leave it till he saw the wisdom of being released from being a salaried officer of the Company. Seeing that we could no longer have the unprejudiced services of Mr. Crookes, and that he had the heavy salary of £600 a year, you can easily understand that we should have been quite ready to receive Mr. Crookes's resignation some months ago. We, however, thought it would be more courteous not to suggest his resignation till he himself saw fit, as he has done to-day, very properly and handsomely to tender it. As to the conditions of acquiring his lamp, one was that we should establish a factory somewhere in the neighbourhood of his own house, and that £10,000 was to be put aside so that his invention might not be allowed to starve. This was a question very anxiously considered by the board, and we had meetings day after day with Mr. Crookes and his friends, but we felt, after the long report we received from the professional gentleman to whom I have referred, and to whom we pinned our faith, to act as we did. The report we had in our hands said we cannot report on the quality of the endurance of these lamps, as we have not had a sufficient number to test, and we shall not recommend you to deal with it till you have tested them for their endurance. I am not saying a word against Mr. Crookes's lamp, but if it should hereafter become the first incandescent lamp in the world, I believe you will approve of the course we took. If Mr. Crookes had brought us twenty incandescent lamps we should have put them through the test. We were very anxious on the subject, but we considered that we were trustees for you, and that having purchased at a very large price on our own responsibility one incandescent lamp, we did not feel justified in giving this large price. From first to last the cost would have been £30,000 to go out of the pockets of the Company for the benefit of having the lamp. I need say no more on the subject. As to our patents and their validity being guaranteed, that is a very important question, but one that no company has been able satisfactorily to settle. I believe we do possess some of the earliest patents, and in a trial that took place in America between the Edison and the Maxim as to which had priority of patents I may tell you that the Maxim gained the day. Therefore, I think we may consider that our Maxim lamp is not challenged. I may also say as to our dynamo machine that, while the Gramme and others are threatened, we have had no threat as to ours, though we may get it any day. Meantime we are going on very successfully with the Maxim and the Weston patents. But, as Mr. Crookes argued, we all think our own babies best. In granting concessions you may have seen that another company which have granted a great number have invariably said that they would not guarantee their patents to those to whom they sold concessions. We were obliged in purchasing the Maxim and Weston patents to accept the same terms, though they offered to pay half the law expenses that might be incurred in testing this validity.

Mr. WILLIAM ABBOTT emphatically held that the course taken by the directors was the best in the interests of the Company. They had several patents, and believed—he for his own part believed—that they had the very best incandescent lamp, and, therefore, why multiply them? Instead of patentees starving he thought that shareholders would starve if that course were adopted. At the last meeting he suggested that the directors should leave municipalities to be dealt with by those enterprising gentlemen who were very anxious to do a large amount of work for very little pay. That might suit those gentleman but not this Company. He would submit to them that the experimental stage had been passed by this Company, and that they should now devote their time to the lighting of factories, &c., and the sale of their lamps, and thus obtain profits as soon as possible. He thought that that was the principle they should adopt, and if it were adopted they need have no fear of the future of the Company.

The CHAIRMAN: That is our intention—to direct our entire attention now to domestic lighting, to obtain such contracts as will bring in actual remunerative work. I think we might have obtained a great deal more work had we been satisfied to do it at bare profits, or no profits at all. There is one point I omitted to allude to. We have had certain overtures made to us for the purchase of one of our patents—the Rapieff lamp, which was included in the patents we bought, but which we have not worked for some time. There are those who think it might be worked profitably, and we are now in treaty for a good round sum for the disposal of that patent. We are so satisfied that the Weston arc and the Maxim incandescent are the patents we can work most satisfactorily with, and with good remuneration, that we have decided, if a favourable opportunity occurred, to part with our Lontin and our Rapieff patents, but we shall not do so except under proper advice. We think it right, as the Company was formed for working the Lontin patent, to tell you that it is our intention to part with the Lontin as well as the Rapieff patents, which we are entitled by the Articles of Association to do as directors for the benefit of the shareholders. I think this is also the moment when I should say a word or two as to the Electric Light Association. It was originated by the Company because we found so much underhand working—greasing palms—going on. We, therefore, invited the co-operation of other companies to form an association to protect our rights and agree as to certain regulations with regard to each other. I think some ten or twelve regulations were drawn up, on which we are acting in concert with each other. We meet at our offices every month, and there transact a great deal of business for the benefit of electric lighting generally. It has been not only of great utility in the forming and arranging of parliamentary business, but useful in certain other matters in which all the companies are interested alike. I may instance one matter, which is the extraordinary rise that insurance companies have made upon houses that have employed the electric light. That is a matter continually under the consideration of this association's meetings, and I think we shall be able to bring it to a very satisfactory issue. To this Company is due the credit of having formed that association, and I hope you will give us credit for having done so. It has been the means of saving us a great deal of money, as we agreed that the associated companies should work with one set of solicitors, and one set of parliamentary agents, and we have agreed, when the Bill passes, to divide the expenses among those companies who are associated. We only agreed to associate ourselves with first-rate companies—not any mushroom company that might spring up at any moment, but certain companies with good names, and well known in the mercantile world.

Mr. ABBOTT suggested, as he was always jealous of the rights of shareholders, that the directors should not part with any of the Company's patents without first laying the matter before a meeting of the shareholders. Such a meeting would cost nothing, and would be more assuring to the proprietors.

The CHAIRMAN: I am afraid you are rather late with respect to the Rapieff patent, as we have entered into a very good contract for that. We have found it impossible to work the Rapieff. The negotiations may lapse in the course of two months, but other parties have the refusal of it for that time. As to the Lontin, we have as yet taken no steps.

A SHAREHOLDER thought the matter might be very well left in the hands of the directors.

The Chairman then put the motion, and it was carried unanimously; and the retiring directors, Sir E. A. Inglefield and Sir H. B. Sandford, were subsequently re-elected.

The CHAIRMAN having replied on behalf of Sir H. B. Sandford and himself,

A resolution was passed re-electing Mr. Henry Dever the auditor of the Company, at a remuneration of 30 guineas.

The meeting was then made special, and

The SECRETARY having read the notice,

The CHAIRMAN said: I have very few words to say, but our reason for the proposed change in the name of the Company is this: when we were first formed we were the sixth Company, and we took the title of the Electric Light and Power Generator Company, thereby enabling us to take any number of patents, work any kind of light and lamp, and to use electricity as a motive power. Since then fifty-four companies have been formed, twenty-three of whom have in a great measure pirated our patents, and also have called themselves Electric Light and Power Companies. One company, in fact, has called itself an Electric Light and Power Generating (not Generator) Company. We, therefore, in these circumstances think it will be better to call ourselves the Maxim-Weston Electric Company, by which, like the Brush Company, we shall be known at once for having these particular lamps, which it will be our business to introduce generally. I have been asked many times, To what company does the Maxim lamp belong? and then when I have mentioned this Company the remark has been, "Oh, the company of which so-and-so is a director," mentioning one of the other twenty-three companies." I think, therefore, you will agree that it is time that we should change our name,

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Mr. John Scarlett Campbell: When we started this Company we were very general in our powers. We wanted a good light, and we felt we were not thoroughly qualified in that respect, but now our lamps will show you what an admirable light we have, and I think we cannot do better than give the names of our lamps to the title of our Company. I second the motion.

The Chairman: It is moved and seconded "That the name of the Company be changed to the 'Maxim-Weston Electric Company (Limited).'" Those in favour of that will signify the same in the usual manner. To the contrary. Carried unanimously.

Mr. William Abbott then moved a vote of thanks to the chairman and directors, and expressed a hope that the directors would do even better for the shareholders in the future.

Mr. G. P. Harding seconded the motion, and it was carried unanimously.

The Chairman acknowledged the vote, and intimated that a special meeting would be necessary to confirm the resolution for altering the name of the Company.—The proceedings then terminated.

THE FAURE ELECTRIC ACCUMULATOR COMPANY (LIMITED).

An extraordinary general meeting of the above Company was held at the Terminus Hotel, Cannon-street, on Thursday, the 29th June, "for the purpose of receiving a statement from the board of directors, and considering the future policy and business of the Company under circumstances which will be explained to the meeting, and, if deemed expedient, of passing resolutions in connection therewith." Sir A. J. Otway, Bart., M.P., presided.

The Secretary (Mr. Herbert Canning) having read the notice convening the meeting,

The Chairman said: Gentlemen, you have heard the terms of the notice which the secretary has just read. We felt it our duty to ask you to meet us to-day for the purpose of carrying out the intention indicated in that notice. I say our duty, because although by the Articles of Association of our Company this board had undoubted right and power to conclude any arrangement that it thought beneficial for the Company, still the proposals which will be made known to you are of a character so important that we thought it due to the shareholders and due to the consideration that men of business should always give to their proprietary to take their opinion before coming to any definitive opinion on the matter which will be brought to your notice. Now, gentlemen, I shall ask you in considering the proposals which will be made known to you and on which you will be asked to give an opinion, I shall urge on you the necessity of considering the circumstances under which these proposals are laid before you. I shall before making known these proposals to you relate briefly the circumstances, and you will then see the importance of the suggestion I have now made. I do not know whether there are many or any of the proprietors present to-day who were with us on the occasion of our last meeting—that of our statutory meeting. If so they will remember that I indicated the policy which this board intended to pursue with regard to the affairs of which we are the administrators. That policy met generally with the approbation of those present. It is unnecessary to repeat what took place, but I will remind you that among the observations made there was one somewhat partaking of the nature of a reproach that we had not disposed of our capital; and one gentleman went so far as to say that we had commenced our business with an insufficient capital. Well, gentlemen, I did not admit at the time the justice of the reproach, but whether it was a well-founded reproach or not, scarcely had I left the room when a somewhat remarkable circumstance took place. I found that the whole of the remainder of our capital had been secured. This was very soon followed—I might almost say simultaneously—by another circumstance not less striking, not less interesting, and hardly less surprising. You are aware that when we last met we had an antagonist, a rival maker of accumulators, a powerful company, entering on business in rivalry with ourselves, and professing to have a better article than we, with which to conjure the public. We never, I need scarcely say, doubted, and, what was more, we knew that this rival accumulator could only be brought into public notice (so far as we were concerned) by violating the rights which we possessed by our patents, and in order to protect those rights, as I told you, we had instituted legal proceedings against the company which affected us. I say, then, it was with no little surprise that we learnt that a company in the supposed possession of an accumulator that was entirely to destroy that of Faure had become suddenly so convinced of the extraordinary merits of the Faure accumulator that it had purchased the patents of the Faure accumulator for all the rest of the world. We now found ourselves in this strange position, that they who were our antagonists the day before had now become more interested in the success and establishment of the Faure Company than we ourselves. Because, whereas we only held those patents for the United Kingdom, they held them for all the rest of the world. I was not at all surprised, under such a state of things, that overtures should even be made to us—a step I should think any business man would take—to come to some understanding with a company so situated as that I have now described. I should tell you that the vendor of the Faure patents for all the world, excepting the United Kingdom, being a gentleman of great ability and considerable personal experience, had very wisely made a condition with the Storage Company, to whom he had parted with them, that they should agree to a basis of understanding with the company in which we had now so very large a stake. Well, these conditions were made to us, and although we were well aware that we had an uphill struggle if we commenced one with the master of many legions, still it would have been our duty to contend wherever we thought the rights of the company—of our shareholders—had been infringed, or where we thought their interests had not been duly consulted. At first, therefore, these conditions, as they were at first offered to us, did not seem acceptable to us, but after long, and I must say exceedingly difficult negotiations—among the most difficult I have ever had—negotiations which were carried on in the largest possible spirit, not in a higgling, huckstering spirit, but influenced by the great interests involved in this matter—above all by the vast importance of establishing peace instead of wasting our money in litigation and our time and energy in unnecessary litigation, and of establishing a union of interests, and binding them into a powerful company without that company having any opponent in the world. Influenced by that spirit we were able to obtain for our company some very valuable concessions, to which we thought ourselves fully entitled, and these concessions were wisely made to our just demands, and I am bound here to recognise the large spirit with which Sir D. Cooper and those other gentlemen of the Storage Company met us, and I must also take the opportunity of recognising the very great assistance we obtained during these negotiations from M. Philippart, the vendor of the Faure patents to the Storage Company, and a very large proprietor in the interests of that company. Well, gentlemen, the result has been that an agreement has been come to if it is sanctioned by you, but in that case only. An agreement had been come to I may say substantially between the two companies. Now I shall ask Mr. Wiseman, who is by my side, to make known to you the heads of the agreement. What I may say shortly to you is this—thus asking you again to remember that which I told you just now, the circumstances under which the negotiations were carried on and the position of the large proprietors—I think you will say—my opinion is you will say—the arrangement is one singularly favourable to the interests of the Faure Company. What I do not hesitate to say is that if an arrangement of the kind were to be made between the two companies, I can hardly conceive that any one could be concluded of a character more favourable to ourselves. Well, now, what has been done is this. We have come to an arrangement of peace I may say first of all—perpetual peace, I hope it will be, between the two companies. I may say almost an alliance offensive and defensive, and we have determined in a clear and definite way what the attributes of each Company are to be as to the manufacture and use of the Faure accumulators. That which we have succeeded in preserving to ourselves is in my opinion—so far as I can form an opinion now—the most valuable of the accumulator business. We have preserved everything for instance connected with railways, either as to propelling purposes or as to lighting their stations, their carriages, their tunnels, their cafés, their restaurants—everything in short connected with railways. We have preserved for ourselves everything connected with ships—their lighting, their propulsion if necessary, whether on the sea, canals, or rivers, in short wherever ships are sailing under the British flag. We have preserved for ourselves the motive power of electricity applied to tramways and vehicles of all descriptions, bicycles, tricycles, and, gentlemen, last but by no means least, we have secured to ourselves the use of the accumulators for machinery of all kinds. You will understand that I mean we have secured the exclusive use of the accumulators for those purposes. Well, that being so, the Storage Company have acquired from us the use of the Faure accumulators in the United Kingdom of Great Britain (they possessed it for all the rest of the world already) for the lighting of houses and towns. In case there should be any omission in details which I am making known to you, Mr. Wiseman, I am sure, will correct me, as he has a *précis* here. I am speaking from the knowledge I have carried in my head for a long time. Well, there are other conditions, and one is a very important one, namely, to establish a community of interest between the two companies we have mutually had an interchange of the rates with value upon shares. When it is considered that we share in these patents, which we think so valuable, for the entire world, and that we gave the United Kingdom only to the Storage Company, I think it will be found that the proportion of the shares interchanged is also very favourable to ourselves. There are some subsidiary arrangements that are entirely favourable to ourselves. They must be favourable to ourselves as they are entirely of an optional character, and anything that is optional cannot be considered unfavourable, but we consider them very valuable. We have a right in sharing, up to a certain time, in the proportion of profits to be derived by the Storage Company in the formation of sub-companies, and the Storage Company will also give us a proportion of all the profits they have made since they began up to the present time—a proportion according to the number of our shares—and, as you are aware, that is not slight. I have now given you the heads of the agreement. I never like to detain shareholders long. I always find it the best plan to make a statement, and to ask any gentleman to whom I have not made myself sufficiently clear, to question me, so that I may explain anything he wishes to know, as far as I am able, and I think that is the best way to conduct the business of a public meeting. I shall, therefore, now conclude the statement, asking you merely to remember my opening observations, because these are all important when you come to consider your decision. This, gentlemen, I feel bound to say, and I would not consent for any consideration whatever to throw before the shareholders, as chairman of a company, a set of conditions, or proposals, without giving my own opinion upon them. I think it is the least that everybody of shareholders has a right to expect from their chairman. I say, therefore, that under the circumstances of the case, I am surprised rather that we should have been able to obtain conditions so favourable as these are. Of course a great deal will depend on working them out. Who may work them out is a question still perhaps to be determined, but I have no hesitation in telling you that still we should consider it a duty to carry out the argreement unless there was a very strong opinion on the part of the shareholders that it was an agreement disadvantageous to themselves. If the shareholders were to express a strong opinion of that kind then I think as practical men that we should be bound to consider such an expression of opinion with respect to such a matter. But I can hardly expect you will express any such opinion. You have heard my explanations, and I shall now ask any of you to make inquiries from me on any point on which you require information, and then I hope that someone in the room will be so good as to move some resolution giving an expression on the part of the body of the shareholders to the general scheme laid before you. I should mention merely that at the present moment the agreement is not signed, because it is not definitive till you have given an opinion on it. It is actually not yet drawn out in a proper manner. I have made it known to you correctly, generally speaking, and if I have omitted to state anything that should be made known Mr. Wiseman will now be so good as to mention it.

Mr. Wiseman (from the office of Messrs. Freshfields and Williams) then read a *précis* of the agreement, recapitulating in a more detailed form and slightly amplifying the information given by the chairman.

In reply to questions the Chairman said: We share for our proportion

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of the Storage Company's capital in the profits of the Faure Company "all over the world" for the whole duration of the patents, and great and powerful as Great Britain is, I don't think these isles can compare in extent with the rest of the world. The gentlemen of the other company were of opinion that they had given much too much value under these circumstances. I have had a good deal of correspondence on this subject, and many shareholders are under the erroneous impression that we have been negotiating as regards the Sellon-Volckmar patents. Not at all. It is the Faure patent that we have been trying to obtain in parts of the world where we cannot use it, although the Sellon-Volckmar is not altogether without value, as I have said. We have exclusive rights as to British vessels, and as they are more numerous than all the other vessels in the world put together we have the most value there.

Mr. E. GREEN: The arrangement you have foreshadowed seems a very satisfactory one, and an advantageous one for our Company. I beg to propose that "The arrangement foreshadowed by the chairman be adopted." I think that the jump that has taken place in our shares already while this arrangement has been in course of progress has shown that it is an undoubted advantage to us.

The motion was duly seconded.

The CHAIRMAN submitted the resolution, and said: I may say that I have not in putting my remarks before you alluded to the point mentioned by a recent speaker, that is, the impression made on the public, at any rate as shown by the increased value of the shares. I always abstain from referring to these matters, and dealing with them on their own merits; but one cannot be indifferent to the value put upon such an arrangement on the part of the public. I have read the resolution. If any one has any observations to make now is the time—if not, I shall put it. The chairman then put the resolution in the usual manner, and declared it carried unanimously.

A vote of thanks to the chairman and directors was then carried unanimously, and in reply

The CHAIRMAN said: I am very much obliged to you. It is our duty to do what we can to carry this affair to a great success. It is one of the most interesting inventions of modern times, and one which I have not the slightest doubt has a very great future before it.

The meeting then separated.

THE METROPOLITAN (BRUSH) ELECTRIC LIGHT and POWER COMPANY (Limited).

Managing Director—ROBERT HAMMOND, Esq.

This Company is now prepared to undertake CONTRACTS for LIGHTING STREETS, Public Buildings, Churches, Theatres, &c., with the Brush Arc Light and the Lane-Fox Incandescent Lamps throughout the whole of the Metropolitan Postal District. Also to supply complete Installations of their system to those who wish to have the Electric Light immediately, instead of waiting for the formation of electric lighting stations, which will shortly be opened, in addition to those at Holborn and Westminster already in operation.

The services of a thoroughly efficient staff will be immediately brought to bear upon any work entrusted to the Company, and they will be happy to arrange for a practical engineer to inspect any premises in order that the exact estimate of the cost of lighting may be given.

The Brush Light has already been erected at Messrs. Peek, Frean, and Co.'s; the Clock Tower, Westminster; Alexandra Palace, the Admiralty, Woolwich Arsenal, South Kensington Museum, the Inns of Court Hotel, the Royal Music Hall, the Combination Stores, and the stations of the South Eastern Railway Company, Great Western Railway, South Western Railway, &c.

All particulars, prices, and estimates may be had from the office of the Company, 110, Cannon-street, E.C.

ROBERT WILSON, Secretary.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES JUNE 28.		BUSINESS DONE WEEK ENDING JUNE 28. Highest.	Lowest
Anglo-American	52¼,	53¼	52½	52
Do. Preferred	82½,	83½	83	81½
Do. Deferred	22½,	23¼	22¾	22
Brazil Submarine	11⅜,	11⅝	11⅝	11 9-16
Cuba	9¾,	10¼	10	9¾
Do. Preference	16,	17	—	—
Direct Spanish	6¼,	6¾	—	—
Do. Preference	15½,	16½	15⅝	15⅝
Direct United States Cable	11¾,	12	11⅞	11 13-16
Eastern Telegraph	9⅞,	10⅛	10⅛	10
Do. 6 per Cent. Preference	13,	13¾	13¼	13
Do. 5 per Cent. Debentures, 1899	102,	107	—	—
Eastern Extension	11⅛,	11⅜	11½	11 3-16
German Union	9¾,	10¼	10⅛	10⅛
Globe Telegraph and Trust Company	6¼,	6¼	6¼	6 5-16
Do. Preference	12⅝,	12⅞	12⅞	12 3-16
Great Northern	12¾,	13¼	13⅛	12 15-16
Indo-European	28,	29	—	—
Mediterranean Extension	2,	2½	—	—
Do. Preference	8¼,	9	—	—
Reuter's	12¾,	13¼	13¼	13¼
Submarine	265,	275	270	270
West India and Panama	1⅜,	1⅝	1⅝	1½
Do. 1st Preference	7¾,	8¼	8 9-16	8¼
Western Brazilian	7¼	7¾	7⅛	7¼
West. Union 7 per Cent. 1st Mortgage	121,	126	—	—
Do. 6 per Cent. Sterling Bonds	102,	105	103½	103½

TELEPHONES.

Consol. Telephone and Maintenance	1½,	1¾	1¾	1½
Oriental	⅜,	¼	¼	¼
United Telephone	13¼,	13¾	14	13⅛

ELECTRIC LIGHT.

Electric Light and Power	¾,	1	1	11-16
Anglo-American Brush	26½,	27½	28¼	25¾
Eastern Electric	4,	4½	4¾	4

WANTED, to place a Youth as PUPIL with a firm of Electrical Engineers, where he will receive thorough practical and theoretical instruction in the modern applications of electricity. Apply to Mr. THOMAS COOTE, North-terrace, Bishops Stortford, Herts.

THE EXCHANGE TELEGRAPH COMPANY, LIMITED.

Head Offices—17 & 18, Cornhill, E.C.; Stock Exchange, E.C.; 27, Regent Street, W.

Incorporated the 28th March, 1872, under the Companies Acts of 1862 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

Not having any springs or clockwork to wind up or to depend on, these instruments are acknowledged by those familiar with the system of telegraphy to be the only instruments yet invented that are capable of doing the work required of them continuously for a lengthened period, as evidenced by the fact that the Gold and Stock Company of New York, having the monopoly of this kind of business in the States, and which owns all the patents of the day of any value, has, after due trial, discarded all others.

The Company is prepared to treat with provincial Companies requiring instruments for the delivery of news for either single or double wire systems under the Company's patents, whereby from central stations identical information can be simultaneously delivered to any number of recipients by automatic, self-adjusting, printing instruments requiring no local batteries, no winding up, and no knowledge of telegraphy on the part of the receiver, the printing being in bold roman type, and the propulsion of the paper being effected by the electricity supplied from the Central Office.

The instruments supplied by the Company can be had to work either on single or double wires, and to print either on a slip or tape of paper, as has hitherto been the custom, or on a broad band of paper in column form.

The system has been in use by the Exchange Telegraph Company (Limited) in the City and West End of London since 1872, and by MacMahon's Telegraphic News Company (Limited), for the delivery of Parliamentary, Sporting, and General Intelligence, since 1879.

The Company will supply householders and others with its

DISTRICT CALL SYSTEM.

By the aid of a small automatic telegraph instrument a Subscriber can at any hour, day or night, call a messenger, cab, or policeman, or give the alarm of fire, and will obtain the required assistance within three minutes of making the signal. Subscribers, when absent from their homes for a season, can leave their houses closed, and have them taken charge of by the Company, and rendered perfectly secure against burglars by a telegraphic communication with the nearest District Call Station of the Company, where a policeman will always be in readiness day and night to respond to calls.

Provincial combinations to work under the Company's Patents will be treated liberally.

The Company is also prepared to supply Municipalities with its system of

STREET FIRE ALARMS

as recommended by H. M. Postal Telegraph Department to the Metropolitan Board of Works for the Metropolitan Fire Brigade, and which has received favourable mention by Captain Shaw in his last annual report.

These Alarms have recently been considerably improved by the Company, and are acknowledged to be the simplest yet constructed.

All communications to be addressed to the Secretary as above.

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

2538. ELECTRIC AND MAGNETIC BRAKES, &c., *M. R. Ward, London.—10th June*, 1881. 6*d*.

The inventor does away with brake blocks, and employs a dynamo-electric machine for each carriage, the machine being connected with and put in motion by an endless band or other gearing from the axles of the carriage. These machines are so arranged that when the circuit in which they are included is closed, the action of the electric energy produced will retard the motion of the train. When the circuit is not closed the dynamo machine will revolve freely, and give out a current which may be utilised to produce heat, light, or to charge secondary batteries, which in turn shall feed excentric lamps.

2739. IMPROVEMENTS IN THE MODE OF AND APPARATUS FOR DISTRIBUTING ELECTRICITY, APPLICABLE TO THE PRODUCTION OF THE ELECTRIC LIGHT, &c., *H. E. Newton, London.—22nd June*, 1881.—(*A communication from A. Gravier, Paris.*) 8*d*.

This invention consists in the application of derived circuits so as to distribute the electric currents to any number of apparatus, which shall all be independent of one another, and shall only absorb the exact amount of current required to work each one.

2954. IMPROVEMENTS IN MAGNETO OR DYNAMO-ELECTRIC MACHINES OR ELECTRIC ENGINES, *P. Jenson, London.—(A communication from T. A. Edison, Menlo Park, N.J.)—6th July*, 1881. 6*d*.

The object of this invention is to do away with the iron core of the armature, and the loss of power through the heating thereof, also to generate continuous currents of high electromotive force in the same direction without using pole chargers. This is accomplished by constructing the armature in the shape of a disc, but divided into radial sections. These sections are naked copper bars joined edgwise by a non-conducting material, so that they form a rigid disc, and rigidly attached to the driving shaft by means of an insulating hub.

2981. MIDDLINGS PURIFIERS, *E. G. Brewer, London.—7th July*, 1881.—(*A communication from K. Smith, Minnesota, U.S.*) 6*d*.

An electrified surface is used to attract the particles of bran, which are removed from its surface, the flour not being attracted, and the inertia of the material as it falls is made use of to separate the middlings and bran to a certain extent, allowing the bran to fall near to the electrified surface and the middlings to be more remote. The middlings pass from a hopper and fall through the air on to an incline or cant board that partially arrests the velocity, and the material rebounds against the cant boards, and then slides off and falls, the meal or flour falling further off than the bran. An electrified surface such as a roller or band of vulcanite acted upon by rubbers is placed as close to the line in which the bran falls as is convenient, and the particles of bran are attracted and removed by scrapers.

2995. IMPROVEMENTS IN TELEPHONIC AND TELEGRAPHIC SIGNALLING APPARATUS, *A. C. Brown and H. A. C. Saunders, London.—7th July*, 1881. 6*d*.

The object of this invention is to facilitate intercommunication between several telephone stations on one wire. The apparatus is so arranged that not only can any station call up and place itself in direct communication with any other station on the same wire without having to go through a central office, but also so that none of the other stations can interrupt or hear what is passing. The instruments and mode of arrangement were illustrated and described in our articles on the Crystal Palace Exhibition.

3009. MONEY TILLS, *B. W. Webb, London,—8th July*, 1881. 8*d*.

The object is to prevent fraud, and consists of a series of toothed wheels and indexes operating to indicate on dials any sum paid, and to simultaneously cause the ringing of electric bells, which tell the amount registered by striking as many times as there are pounds, shillings, or pence in the amount received.

3032. IMPROVEMENTS IN REGULATING ELECTRIC CURRENTS AND IN THE APPRATUS OR MEANS EMPLOYED THEREIN, *Sir W. Thomson, Glasgow.—9th July*, 1881. 10*d*.

This invention consists in an automatic appliance for regulating by means of electro-magnetic force the work of an electric accumulator or voltaic battery by increasing or diminishing the number of working cells. One species of this appliance gives a constant strength of current, another a constant electromotive force.

3073. IMPROVEMENTS IN LAMP CASINGS OR HOLDERS FOR CONTAINING AND PROTECTING ELECTRIC LIGHTS, &c., *D. Graham, jun, Glasgow.—14th July*, 1881.—(*Not proceeded with.*) 2*d*.

This relates to an improved kind of lanthorn for holding incandescent and arc lamps, and to a means for fixing the lamps in the lanthorn. Also to an improved contact piece in which water and mercury are contained, the water being designed to prevent the spark occasioned by contact being made from setting fire to any gases, &c., that may be near

3122. IMPROVEMENTS IN THE MANUFACTURE OF ELECTRIC BRIDGES FOR LAMPS, *St. George Lane-Fox, Westminter.—18th July*, 1881. 2*d*.

The inventor uses the Italian grass (Andropogon Ischœmum), known as French whisk, for his electric bridges, or carbons, for incandescent lamps. He boils the grass in a solution of caustic soda (5 per cent.) The outer skin is then scraped off, and the fibre boiled in water. It is then straightened, bound on a block of carbon, burned in a crucible, and carbonised.

3228. IMPROVEMENTS IN APPRATUS FOR CONTROLLING TELEPHONIC COMMICATIONS, *J. Imray, London.—23rd July*, 1881.—(*A communication from L. A. Brasseur and O. Dejaer, Brussels.*) 8*d*.

The improvements consist in the use of a distributing tablet, as it is called by the inventors, which has a number of keyholes, one for each subscriber. When a subscriber A wants to communicate with another B, a key is placed in A's hole in the tablet, and when turned, disconnects the signal. The attendant at the commutator then does the same, and communicates with A, and subsequently informs the attendant at the tablet that he wishes to communicate with B, the latter puts another key into the hole belonging to B, and by turning it puts him into communication with A. The key consists of a shank on which are insulated pieces of metal, which on the key being turned one quarter round bears against lateral springs fixed on an ebonite casing of the key; these springs communicate by insulated wires with the line, return, and battery. The key cannot be withdrawn without turning it back, and this act connects A and B to central office. By means of interrupters, any attempt to listen to the conversation of A and B by connecting up to their line breaks up the connection between them, and by means of a current from the central station informs them of the interruption. Induction is avoided with instuments having two wires by combining with them one inducing and two induced coils.

3327. ELECTRIC APPARATUS FOR AUTOMATICALLY GIVING ALARMS, *J. L. Rastrick, London.—30th July*, 1881.—(*Not proceeded with.*) 2*d*.

The expansion of matter was utilised to cause an electric contact, and hence to give an alarm.

3404. IMPROVEMENTS IN APPARATUS OR APPLIANCES FOR AUTOMATICALLY LIGHTING ELECTRIC CANDLES, *E. G. Brewer, London.—5th August*, 1881.—(*A communication from A. G. Desquiens, Paris.—(Not proceeded with.)* 2*d*.

The invention consists of two supports for each candle, having levers and arms acted on by springs which put the two supports in electric connection when the candle is consumed. The springs are released by the action of heat on a brass pin placed at the bottom of the candle.

3509. IMPROVEMENTS IN ELECTRICAL INTERRUPTERS, *P. Ullathorne, London.—12th August*, 1881. 6*d*.

The instrument consists of three stretched wires nearly parallel but not in the same plane. The contact or anvil wire is platinised at its contact point, and is insulated from the other two which are attached to the ends of a soft iron armature, lying in a plane between the contact wire and the other two external wires; the part of the armature making contact is also platinised. The wires are stretched over bridges, so that the armature bisects the vibrating portion of the wires to which it is attached, and these are equally stretched and equal in other respects. The contact wire is also stretched on bridges, one of which is near the armature. An electro-magnet is placed on that side of the armature furthest from the contact wire. Supposing the current to enter the electro-magnet, it passes to the ends of the armature wire and into the armature; from here it goes to the contact wire, and exits from one or both ends of the vibrating part of the contact wire. Modifications of this mode of construction are also described and the instruments illustrated.

3559. IMPROVEMENTS IN ELECTRIC LIGHTING AND IN THE MEANS OR APPARATUS EMPLOYED THEREIN, *C. W. Harrison, London.—16th August*, 1881. 6*d*.

The inventor makes use of a reflector of solid roestone in slabs, or uses it as a base, and mixes therewith gypsum and oolite, bringing the whole into a fluid state by a solution of potash; the mixture is then dried in blocks at a low heat, and subsequently hydraulicly pressed into a hard mass. The inventor varies the colour of the light given by the arc by adding liquid sulphates of various bodies to this reflecting material, according to the tint required.

3668. IMPROVEMENTS IN ELECTRIC LIGHTING APPARATUS, *W. R. Lake, London.—23rd August*, 1881.—(*A communication from T. A. Connolly, Washington, U.S.*) 6*d*.

This consists in the employment of an automatic switch in connection with the electro-magnet, through which the upper carbon is fed, by means of which, should the arc become defective from any cause, the current will be diverted through the lamp frame, and out at the same terminal as when the arc was established, so that the other lamps in circuit would not be affected. The feeding of the carbons is accomplished by clamps attached to the armatures of electro-magnets.

3754. IMPROVEMENTS IN SHEATHING OR COATING METAL SURFACES, &c., *W. Elmore and J. J. Atkinson, London.—29th August*, 1881. 6*d*.

The inventors employ an electric motor hung upon rods around the work to be coated, and driven by this motor a hand emery wheel for cleaning the spots or metal required to be covered. They also use an electrical depositing tool consisting of a conducting rod, carrying at its end a disc of the metal to be deposited, which forms the anode. This disc is covered with a pad of felt, moistened with a solution of the above metal, it is then brought into contact with the surface to be coated. The cathode wire of the circuit is then connected with the metal to be coated and the wetting pad applied, when a deposit of the metal is effected on the cleaned surface. Thus the coating of the spots that have been cleaned is effected with great rapidity.

3804. IMPROVEMENTS IN COMMUTATORS FOR DYNAMO OR MAGNETO ELECTRIC MACHINES AND ELECTRIC MOTORS, &c., *P. Jensen, London.—1st Septmber*, 1881.—(*A communication from T. A. Edison, Menlo Park, New Jersey, U.S.*) 4*d*.

The inventor makes his commutator bars and brushes of copper, and amalgamates their surfaces directly with mercury; or they are faced with silver and afterwards amalgamated; this reduces sparks.

3812. AN IMPROVED METHOD OF AND APPARATUS FOR TRANSMITTING SECRET MESSAGES BY ELECTRO-MAGNETIC TELEGRAPH, *W. R. Lake, London.—(A communication from A. F. and F. B. Johnson Brooklyn, New York.)—2nd September*, 1881. 10*d*.

This invention relates to a method of transmitting secret messages by electro-magnetic telegraph instruments over ordinary telegraph wires. The inventors use three instruments; one by which the sender of the message himself prepares it for transmission by means of indentations made by the machine on a strip of paper; a second, which the indented paper passes through, and thereby causes the third or receiving instrument, with which it is connected by ordinary telegraph wires, to operate automatically and receive and print the message. The receiver prints the message in ordinary alphabetical letters whilst it is concealed from view and enclosing and addressing it for delivery. The invention is described at great length, and with detail drawings.

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THE
SCHOOL OF TELEGRAPHY & ELECTRICAL ENGINEERING.

ESTABLISHED IN 1868.

12, PRINCES STREET, CORNER OF HANOVER SQUARE, LONDON, W.

(Removed from 4, George Street, Hanover Square.)

MANAGING DIRECTOR: Mr. T. J. JONES, M.S.T.E.

The course of Practical and Theoretical Instruction in the higher branches of Overland and Submarine Telegraphy embraces, in addition to the manipulation of he various systems of working in general use, the following subjects:—

MATHEMATICS, MECHANICS, and CHEMISTRY, } In relation to Telegraphy.	SIGNALLING and TESTING INSTRUMENTS. ENGINEERING FORMULÆ and their Application in Practice.	ELECTRO-STATICS. ELECTRO-DYNAMICS. MAGNETISM.	METHODS of TESTING the ELECTRICAL CONDITION of a LINE During and After its Construction. TESTING FOR and LOCALISING FAULTS, &c., &c., &c.

The instruction, both in signalling and testing, is of a thoroughly practical character, as the classes work with the actual instruments used on long lines, through cables of various lengths, from 600 to 3,000 knots, so that the signals of the Eastern, Atlantic, and Brazilian Co.'s, &c., are exactly reproduced, and the pupils fitted for any line.

A complete practical and theoretical course of instruction on the TELEPHONE and the ELECTRIC LIGHT, and their commercial utilisation, has now been added to, and embodied in, the ordinary curriculum, as the advantage of being associated with any great commercial application of science at an early period of its development is one which has been so often exemplified that it can scarcely fail to be appreciated by those who have in view professional success.

That **TELEPHONIC** communication and **ELECTRIC LIGHTING** constitute such applications is sufficiently shown by their rapidly increasing progress; and therefore no pains or expense have been spared to place at the disposal of the pupils the technical and scientific instruction requisite to qualify candidates for the most important posts in connection with these new branches of electrical engineering. In order that the instruction in the erection, adjustment, testing, and working of **TELEPHONE** and **ELECTRIC LIGHT** circuits may also be thoroughly practical, complete working telephone exchanges upon the various systems in use in different countries have been fitted up; every kind of telephone, for both exchange systems and private lines, with all apparatus used therewith, is provided (in duplicate when possible, so that students may be able to dissect and reconstruct the same). The necessary tools and materials are available, and every facility is given for conducting experiments by the pupils desirous of so doing, and a similar course is being pursued with the **VARIOUS LAMPS** and **MACHINES**, &c., in the **ELECTRIC LIGHT** Department, so that pupils from the School are in a position to enter either of these new fields.

The complete Practical and Theoretical course extends over a period of Six Months.

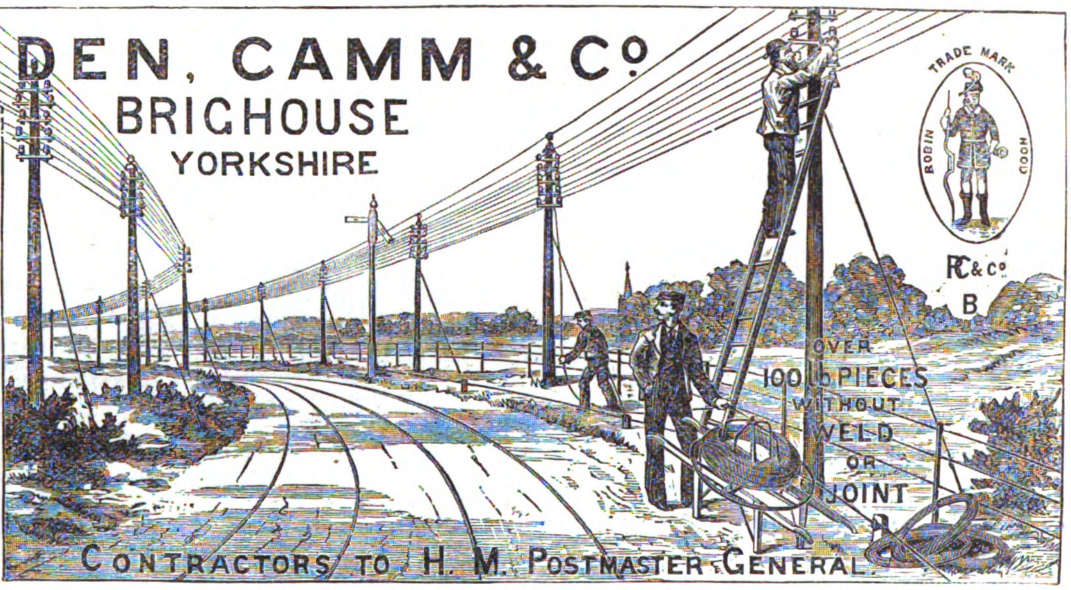
Arrangements have been made so that Inventors, Amateurs, and others can now have every facility, with all necessary apparatus provided in private rooms, to compare, test, or perfect any Inventions, Apparatus, &c., connected with Telegraphy, Telephony, and the Electric Light. Financial and the highest professional assistance can also be had.

Further particulars may be obtained on application to W. N. TIDDY, *Secretary.*

RAMSDEN, CAMM & Co

Manufacturers OF **Patent Telegraph Wire** TO GOVERNMENT SPECIFICATIONS.

Best Refined Telephone Wire,
Fencing Wire,
Submarine Cable Wire,
Strand and Stay Wire,
AND
Galvanised Binding Wire.



London Office: 72, KING WILLIAM STREET, E.C. (GEORGE W. SHARE & CO.)

IMPORTANT TO TELEGRAPH COMPANIES.

THE SANITAS COMPANY (Limited), of Bethnal Green, E., have received the following gratifying letters upon the subject of Sanitas and its uses at Foreign Telegraph Stations:—

"THE MANAGING DIRECTOR, THE SANITAS COMPANY (LIMITED). "February 4th, 1880.

"We have now for more than a year been using your SANITAS soap and disinfectants in our ships, as well as at our stations, and find it greatly appreciated, more especially at tropical places, where the importance of sanitary arrangements is not well understood."

"London, 15th November, 1880.

"I think it right to inform you that our Superintendent at Mozambique says:—'I use the much-prized "SANITAS" freely, and feel perfectly safe wherever I sprinkle it.' "JAMES ANDERSON, Managing Director, Eastern Telegraph Company (Limited), 66, Old Broad-street, E.C."

"SANITAS" DISINFECTING FLUID, No. 1, in 1/- and 2/6 bottles.
"SANITAS" DISINFECTING FLUID, No. 2, in 1/- pints.
"SANITAS" DISINFECTING OIL, @ 30/- per gallon.
"SANITAS" TOILET FLUID, in 1/- and 2/6 bottles.
"SANITAS" DISINFECTING POWDER, in 1/- boxes, and 17/6 per cwt.
"SANITAS" TOILET and NURSERY POWDER, in 1/- boxes.
"SANITAS" TOOTH POWDER, in 1/- boxes.
"SANITAS" DISINFECTING HARD SOAP, No. 1, in 6d. bars.
"SANITAS" DISINFECTING HARD SOAP, No. 2, in 4d. bars.
"SANITAS" SOFT SOAP, in 1/-, 1/9, 3/-, 5/-, 9/-, 12/6, and 24/- sizes.
"SANITAS" TOILET SOAP, in 1/6 boxes of three tablets.
"SANITAS" DISINFECTING FURNITURE CREAM, in 1/- bottles.
"SANITAS" DISINFECTING OINTMENT, in 1/- and 3/6 sizes.
"SANITAS" VETERINARY OINTMENT, in 2/6 tins.

SANITAS is Non-Poisonous and Without Stain, and is used by 400 Public Bodies.

ELECTRICAL.—A Gentleman who has taken high mathematical honours at Cambridge, is a Doctor of Science of the London University in Electricity, a good chemist, and acquainted with the French and German languages, desires an ENGAGEMENT which would occupy the whole or part of his time. Address, Cantab, care of Messrs. E. and F. N. Spon, Scientific Booksellers, Charing Cross.

A GENTLEMAN who thoroughly understands the manufacture, in all its branches, of Incandescent Lamps, is about to start for Australia. He would undertake the SOLE MANAGEMENT of a Company for the manufacture of Incandescent Lamps. Is a good manager and careful buyer. Highest references.
Address, for one week only, "Stone," ELECTRICIAN Office, 396, Strand, W.C.

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SLIP

Electric Light in Buda-Pesth.—The post office in this city is lighted by Edison lamps.

New Zealand.—News from this colony reports the splicing of the Cook's Straits cable by the steamer "Agnes."

Dissolution of a Company.—The Société Générale pour l'Utilisation des Forces Electriques, of 9, Rue d'Antin, Paris, has been dissolved.

The Magazines.—Mr. W. H. Preece, F.R.S., continues his contribution to *Time*, this month's article dealing chiefly with the telephone.

Tasmania.—The latest news from this colony reports that about seven miles of telegraph wire had been blown down near Circular Head by a series of heavy gales.

Electric Light In Havana.—The café of "El Louvre," in Havana, Cuba, has been lighted up by Edison lamps. The lights excite considerable curiosity amongst the inhabitants.

Direct Spanish Telegraph Company.—The estimated traffic receipts of this company for the month of June were £1,963, against £1,456 in the corresponding period of last year.

Barbadoes.—The result of the Telegraphic Conference has been submitted to the Legislature, but the report leaves the question pretty much in the *status quo ante.—Colonies and India.*

Electric Light in Shops.—Messrs. Bowron, who are the proprietors of large provision stores in the Edgware-road, W., are going to light up their premises by means of Swan lamps.

Eastern Telegraph Company.—The traffic receipts of this company for the month of June amounted to £46,450, against £40,074 in the corresponding period of 1881, being an increase of £6,376.

Dutch East Indies.—M. A. Brummd has been appointed Chief of Posts and Telegraphs in the Dutch East Indies, vice M. Janssen van Raig, who has been compelled to return to Europe to recruit his health.

Eastern Extension Telegraph Company.—The traffic receipts of this company for the month of June amounted to £31,123, against £29,339 for the corresponding period of 1881, being an increase of £1,783.

Underground Telegraphs in Glasgow.—At the last meeting of the Glasgow Town Council permission was granted to the Post Office authorities to extend the telegraph line underground from Glasgow to Springburn.

West Indies.—The cables between St. Vincent and Grenada, and between Guadeloupe and Dominica, are now repaired; and telegraphic communication is, therefore, restored with all places in the West Indies.

Electric Light in Kendal.—Messrs. G. Gilkes and Co., ironfounders, of Kendal, Westmoreland, recently lit up part of their works with Swan lamps, in order to exhibit its qualities to the Town Council and other residents of the locality.

The Electric Light Bill.—The *Daily News* says: "Though the Electric Light Bill was not mentioned in Mr. Gladstone's category of measures intended to pass this Session, such intention is held, and will probably be carried into effect."

Appointment.—Mr. A. F. A. Hervey, lately in the employ of Messrs. Woodhouse and Ransom, has been appointed engineer to the Australasian Electric Light, Power, and Storage Company (Brush system), and leaves England on the 13th inst.

Electric Light in Antwerp.—Forty-five A, 16 candle, and 40 B, 8 candle, Edison lamps have been established in Messrs. Gits, Segers, and Co.'s sugar refinery at Antwerp. We believe that another of this firm's factories is to be lit by 300 lamps shortly.

The Edison Light in Chicago.—A company has been formed in Chicago under the title of the Western Edison Light Company, and owns Edison's patents for the states of Illinois, Wisconsin, and Iowa. Its head offices are in Wabash-avenue, Chicago.

War Preparations.—A telegraph train is being got ready at Woolwich, in anticipation of hostilities in Egypt. It consists of four telegraph offices, ten wire waggons, carrying thirty miles of wire, four air line waggons, and four Royal Engineer general service waggons.

New Companies.—The Electric "Sun" Lamp and Power Company has a capital of £200,000, and has been formed to work the patent rights of the Lampe-Soleil. Its offices are at 6, Old Jewry, E.C.—The Anglo-Italian Brush Electric Light Company has a capital of £400,000.

Anglo-American Telegraph Company.—The directors of this company have resolved, after placing £37,500 to the renewal fund, to declare an interim dividend for the quarter ending 30th June, 1882, of 15s. per cent. on the Ordinary stock and 30s. per cent. on the Preferred stock.

Lighting for Wimbledon.—The Wimbledon Local Board are asking for tenders for lighting about three hundred of their street lamps with gas *or otherwise* for one year, commencing August 1st. Tenders must be sent to the clerk of the board on or before noon on the 17th inst.

Great Northern Telegraph Company.—The traffic receipts of this company for June amounted to £22,560, against £115,560 for the period from 1st January to 30th June, and £114,966 for the corresponding months of 1881. The receipts for the same period of 1880 were £108,035.

The Sanitas Company.—The directors of this company, after providing for the usual interest at the rate of 5 per cent. per annum on the preference shares, have decided to pay an interim dividend upon the ordinary shares for the half year ending June 30th, 1882, at the rate of 10 per cent. per annum.

New Ship.—On Thursday week Messrs. John Elder and Co., of Glasgow, launched the steel paddle ship "Normandy," which they have built for the London, Brighton, and South Coast and the Western of France Railway Companies. Her gross tonnage is 600 tons. She is handsomely fitted up, and is supplied with electric lights.

Edison's Dynamos.—The dynamos made by the Edison Company are in six sizes, as follow:—E size, for 15 lights; Z, 60 lights; L, 125 lights; K, 250 lights; R, 500 lights; and C, 1,200 lights. The capacities as given above are for A lamps of 16 candle-power, and each machine will generate current for double the number of B lamps of 8 candle-power.

Proposed New Atlantic Cable.—A telegram to the *Daily News*, dated New York, Tuesday, says: "The Senate passed yesterday the Bill granting a charter to the Baltimore and Ohio Railway Company to lay an ocean cable between this country and Europe. It specifies that the Company

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shall begin to lay the cable within two years of the passage of the Act.

New Company.—The Société l'Eclairage Electrique has been formed in Paris. It has a capital of 6,550,000 francs, and is the result of the merging of the Société Générale d'Electricité, working the Jablochkoff patents, and the Compagnie Générale d'Electricité into one. The new company will work the patents of Gramme, Jablochkoff, and Maxim, the first for his machine, and the two latter for their lamps.

Cuba Submarine Telegraph Company.—The number of messages passing over the lines of this company during the month of June was 3,022, estimated to produce £2,900, against 2,757 messages, producing £2,837 in the corresponding month of last year. The traffic receipts for the months of March and April, estimated at £4,000 and £3,800, realised £4,123 and £3,921.

Cuba Submarine Telegraph Company.—The directors of this Company have resolved, after providing for the dividend on the preference shares and placing £3,950 to the reserve fund, to recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income-tax, leaving £2,145 to be carried forward to the current half year's account.

Electric Lighting at Cape Town.—The Edison incandescent lamps, about three hundred in number, which were shipped some months ago to the order of the Cape Town Government, and which have been installed in the House of General Assembly, are reported to have worked admirably without a single hitch, and are giving complete satisfaction. The order was, we believe, executed in England by Mr. W. H. Preece.

An Electric Railway for Turin.—It is intended to hold an Exhibition at Turin in 1884, and in connection therewith an electric railway is to be constructed, running from the Place Carlo Felix to the grounds of the Exhibition. It is proposed to traverse the Course Victor Emmanuel and the Course Massino d'Azeglio del Valentino, and an effort will be made to open it to the public at least four months before the opening of the Exhibition.

Electric Light for Poole (Dorset).—The Town Council of Poole are inviting tenders for lighting the borough by electric lights, or other means, for one or three years, at their option, from the 1st September next. The amount of illuminating power in candles is to be specified in the tender. Specifications giving the conditions as to lighting by gas or mineral oil can be seen and forms of tender obtained at the Town Clerk's Office, Poole. Sealed tenders, marked "Tender for Lighting," are to be sent to the town clerk by the 21st July.

Opposition to the Electric Lighting Bill.—Colonel Makins, M.P., has given notice that on the motion for going into committee on the Electric Lighting (re-committed) Bill he will move—"That the power given to local authorities, under Clauses 5 and 6 and other parts of the Bill, to raise money on the credit of local rates, without the consent of the ratepayers, for the purpose of competing with private capital raised for a like purpose under the sanction of Parliament, is contrary to every principle hitherto recognised by the Legislature, and that no Bill containing such power will be acceptable to this House."

Electric Light for Limerick Harbour.—The Harbour Commissioners of Limerick are inviting tenders for lighting the docks and a portion of the quays by electric light for three years from the 28th August next. A plan and specification can be seen at the office of the harbour engineer between 11 a.m. and 2 p.m. Tenders are to be sent in marked "Tender for Electric Lighting," and addressed to the Secretary, Harbour Commissioners, Chamber of Commerce, Limerick, before noon on the 13th July. Ten and sixpence will be charged for the specification, but this sum will be returned to those tendering.

Church Struck by Lightning.—During a thunderstorm at Liversedge, Yorks., in the latter part of last week, Christchurch, in that town, was struck by lightning whilst the congregation were singing the "Te Deum." A large stone was removed from the tower and the spouting demolished. The building was suddenly filled with flame, and the gas, which during the darkness had been lit, was blown out. A panic ensued, and the congregation (many being children) rushed to the doors to escape. Fortunately no one was hurt, and numbers of the congregation returned and took part in a thanksgiving service, after which the ordinary service was concluded.

The Panama Canal.—According to the report recently presented to the annual meeting of the shareholders of this company in Paris, the telegraph seems to be largely made use of in connection with the works. The report says that stations comprising houses for the engineers, foremen, and workmen have been built on the hills in proximity to the works. Each station is to have its hospital, with forty beds, its telegraph office, its storehouse, and its workshop. A direct line of telegraph has also been established between Colon and Panama, and another line places all the abovementioned stations in communication with each other and the two extremities of the works.

"Induction."—This is the title of a little book by Mr. Willoughby Smith which has just been issued. The title is short and the book small, consisting as it does of but seventeen pages of large print, but the information it contains is most valuable, comprising interesting particulars of the various experiments which led Mr. Smith up to his latest discovery, the inductophone. We merely wish to call attention to this publication now. We shall deal at greater length with Mr. Smith's researches, as recounted by himself, in a future issue, when we shall hope to be able to do the subject the justice which it demands at our hands. The inductophone was illustrated and described in our issue for June 3.

Electric Light for Camberwell.—The Vestry of Camberwell notify that the revised specification for the supply of electric lighting in parts of their parish may be obtained on application to Mr. George W. Marsden, vestry clerk, Vestry Hall, Peckham-road, S.E. The roads proposed to be lighted are Camberwell-road, Church-street, Camberwell; Peckham-road, and High-street, and Queen's-road, Peckham. Tenders are to be for supplying light from sunset to sunrise, for twelve months, from the 2nd of October next. The present gas lamp columns may be used by the contractor, or he may erect special posts of his own, but in carrying out the works no disturbance of the present gas lamps will be allowed. Tenders are to be sent in addressed to the General Purposes Committee, Vestry Hall, Camberwell, before the 17th inst., at four o'clock. Further particulars can be had of Mr. J. C. Reynolds, surveyor to the vestry, at the Vestry Hall, Camberwell.

A Vessel Struck by Lightning.—Particulars have just been received at Liverpool of a remarkable disaster to the

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vessel "Gertie May." The "Gertie May" was 174 miles from Matinicus on the 18th ult., when she was struck by lightning, which first caught the foretopmast, breaking some three feet off it, then ran to the bow, smashing a portion of the stem; thence to the forecastle, where were ten of the crew in different attitudes, some sitting and some standing. All alike were rendered instantly insensible, but recovered a short time afterwards. The lightning traversed the whole of the vessel, eventually returning to the fore part, where it knocked out two of the vessel's planks in the stem. Fortunately the damage was above the water-line. The vessel had a quantity of salt on board, and this was removed to right her and prevent her sinking. The flag, which was flying on the mainmast, was completely consumed. The "Gertie May" reached Portland on the following day, and lay up for repairs.

Proposed Gas and Electric Light Exhibition.—It has been finally decided by the Crystal Palace authorities to hold this exhibition in the autumn. We have no doubt that representatives of the various electric light systems will be well to the fore in order to show what can be done with their lights, when opposed to gas. If the efforts that will be made by the representatives of the latter method of lighting may be at all gauged by the efforts that are being made by the journals representing their interest, a thoroughly good exhibition of gas lighting should result. Our excellent contemporary, the *Journal of Gas Lighting*, has done its very best to stir up gas people. We shall see what will be the answer to its appeals. The *Journal* thinks that there is some need that gas should be brought before the public in a different garb to that in which it usually appears, so as to give them a chance of seeing what it *can* do. Speaking of the effects of the recent Exhibition, our contemporary thinks that it "did a vast amount of harm among impressionable people; although well-instructed observers of the progress of electrical science failed to see anything new in it. Still, a wide allowance must be made for average human nature, and it is not to be wondered at, by the skilled observer of his kind, that the artful displays of lighting in gorgeously-decorated and furnished rooms appealed more powerfully to the public than any number of learned lectures or published descriptions of Mr. Edison's or Mr. Swan's doings." The *Journal*, therefore, thinks that gas had better go and do likewise. The only question is, when the public have seen what gas *can* do, will they put up with its ordinary performances?

International Electric and Gas Exhibition.—The following notice has been issued by Major Flood Page with reference to this proposed Exhibition:—"The third of the series of International Exhibitions will be opened in the Crystal Palace, Sydenham, in October, 1882, and continued till the end of Easter week, 1883. Applications for space, English and foreign, should be made to the Manager, Crystal Palace, before 1st August, 1882. Their admission and the space assigned to them, together with the regulations, will be notified to exhibitors as soon as is practicable. Printed forms of application for admission can be had from the Manager, Crystal Palace, Sydenham, London. The principal objects to be admitted are comprised in the following: (*a*) Apparatus used for the production and transmission of electricity. (*b*) Magnets, natural and artificial; mariners' compasses. (*c*) Applications of electricity: To telegraphy and the transmission of sound; to the production of heat; to lighting and the production of light; to the service of lighthouses and signals; to apparatus giving warning; to mines, railways, and navigation; to military art; to fine arts; to electro-chemistry, galvano-plastic and chemical arts; to the production and transmission of motive power; to mechanical arts and horology; to medicine and surgery; to astronomy, meteorology, geodesy; to agriculture in its application to industries; to apparatus for registering; to domestic uses; lightning conductors. (*d*) Apparatus connected with the manufacture of gas, and also models. (*e*) Gas apparatus of every kind, and also models. (*f*) Gas engines and also models. (*g*) Cooking by gas. (*h*) Heating by gas. (*i*) Chandeliers, burners, private and public gas lamps."

The St. Gothard Cable.—Our contemporary, the *Journal Télégraphique*, gives some particulars of this cable, from which we extract the following:—"It was manufactured by Messrs. Felten and Guilleaume, at Cologne, and cost 4,750 francs per kilometre, delivered at Basle. The conditions which it was to fulfil were as follow:—There were to be seven conductors, each of which was to be formed of a strand of seven copper wires, each ·7 millimetre in diameter, making the strand itself 1·84 millimetre diameter. The conductivity of these conductors was to be such that the core would offer a maximum resistance per kilometre of seven Siemens units at a temperature of 15° C. The material for insulating each strand was composed of four layers, the first being of Chatterton's compound applied direct to the copper, the second of gutta percha, the third of Chatterton's compound, and the last of gutta percha. This insulation made the diameter of each strand 5·2 millimetres. The resistance which the insulation of each strand was to offer was to be one thousand millions of Siemens units at 15° C, and its minimum electrostatic capacity was to be ·21 of a microfarad. Each strand was wound round with a layer of tarred hemp, which kept the centres of the strands at a distance of seven millimetres from each other. The seven strands thus covered formed a single strand wound in its turn with two layers of tarred hemp, the whole being protected by a covering of ten galvanised iron wires of 4·4 millimetres diameter, and over these was wound a layer of tarred hempen twine three millimetres thick. The cable was to be delivered in sections of 1,000 metres long, so that for the whole length of the tunnel fifteen of these sections were required, and fourteen joints had to be made. The maker was allowed a deviation of 5 per cent. on all these different conditions.

The Telephone at Greenock.—There are at present over seventy subscribers to the Greenock Exchange of the National Telephone Company. The police stations, fire stations, and gas office are also connected, so that in the event of fire, communication with the respective stations can be readily and quickly effected. This exchange has also for some time past been in communication with the same company's exchange at Glasgow by a trunk line which is rented from the post office; the distance between the two exchanges is about twenty-three miles. We believe that a large amount of business is transacted between the two towns by means of this line. Recently, a subscriber to the exchange has had himself put in communication with a church in St. George's-square, as, being an invalid, he is unable to attend service. On the first Sunday on which communication was effected, the Hillhead Exchange, which is two miles from Glasgow, was also switched on to the church, and the service followed by Mr. D. Johnstone Smith, secretary to the Exchange. Mr. Johnstone Smith describes his experiences as follows:—"I distinctly heard the sermon, the text being from the sixth chapter of Hebrews, and the words 'Heirs of promise.' Occasionally I lost a sentence, but, on the whole, it was very perfect; the hymns given out, the organist playing them over, the rustle

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made by the people rising, the volume of sound by the large congregation singing, every note coming out quite clearly and distinctly, and the whole effect very fine. The benediction (followed by a few moments of quiet) and the rustle made by the people leaving were distinctly heard." The distance between the church and the Hillhead Exchange is about twenty-five miles. The Greenock Exchange has for the last six months been under the able managership of Mr. J. D. Miller.

How Reports are Made.—Professor Silvanus P. Thompson, in a letter written to a Bristol paper, criticises a report by Mr. Kitt, C.E., and Mr. Low, presented by these gentlemen to the Bristol Sanitary Authority, and dealing with the Crystal Palace Electric Exhibition. It appears that these gentlemen stated in their report that "the *arc* lights of the Edison Company were very steady," and that "they appeared to possess an equal amount of illuminating power to those of the Brush Company." Professor Thompson points out that there was not an Edison arc light in the whole Exhibition, and conjectures that the reporters mistook Siemens's or Crompton's lamps for "Edison arc lights." Then these gentlemen seem to have swallowed and recorded the fact communicated to them by an attendant at a stall where eight-candle Edison lamps were burning with sixteen-candle gas burners, that it required a number of the former to compete with the latter. We suppose it did, probably twice the number. They also seem to have thought that in some rooms there were too many electric lights, that Edison machines were "very ugly and unsightly things," and that compared with gas the Jablochkoff system was the cheapest. With reference to the first of these rather novel ideas, Professor Thompson asks, "Does the bad taste of people who overdo the lighting of a room by electricity prove anything more than that the same people would indulge the same bad taste in lighting by gas?" In regard to the second, he asks, "Are there not other things almost as worthy of censure? It will take a great deal to convince most people that a gas retort and a gasometer are more lovely or picturesque," and with regard to the last, he says,—"The system, though a most effective and meritorious system, is perfectly well known to be the least economical of all arc lights. Is it possible that no more recent data, or no data concerning more economical systems, have yet reached official ears?" We have quoted enough from this so-called report to show how extremely little the reporters knew of their subject, and how very unreliable was the information they obtained.

Electric Lighting in the City.—At the meeting of the Commissioners of Sewers on Tuesday last a petition was presented by the Hammond Electric Light and Power Supply Company and the Electric Light and Power Generator Company stating that they had been invited to tender, and had tendered, for the lighting of certain of the thoroughfares of the City. In tendering they had estimated that the lighting would be for one year only, and experimental in its character, and they had therefore been obliged to take into account that part of their plant and materials would be useless at the end of the year, but if the Court gave more permanency of character to the contract, they would be able to make a lower tender. As far as the lighting of shops and warehouses went they could do so by means of running cables into them from the streets. Such lighting was a most remunerative undertaking, and if the Commission thought fit to give to the petitioners and to the ratepayers the right of coming to an agreement with reference to private lighting *en route* they would be in a position to make a tender very much lower than hitherto. The petition was referred to the Streets Committee. A petition was presented at the last Court from merchants and traders asking the Court to grant to the Electric Lighting Companies the right of lighting private houses, shops, and warehouses *en route* and adjacent, and of continuing their contracts for not less than three years, subject to the right of the Commission in the public interest to determine the contracts should they prove detrimental to the public. The Streets Committee had had the matter under consideration, and also the further question whether steps should not be taken to provide that all arrangements in regard to electric lighting within the City, whether of the public ways or private premises, necessitating interference with the pavements, should be undertaken by the Commissioners; and they reported that in their opinion the wishes of the memorialists should be complied with and provided for in any arrangements that might hereafter be considered desirable with respect to the electric lighting of the City, and expressing a strong opinion that that duty should be undertaken by the Commission. The report was referred back for further consideration. Full details of the tenders sent in for lighting the new districts of the City will be given next week.

A Pioneer in Telegraphy.—A correspondent has contributed the following to the daily press:—"Mr. John Watkins Brett and his brother, Mr. Jacob Brett, may unquestionably be designated as the original projectors (if not inventors) of the Submarine Telegraph, for as far back as July, 1845, the Messrs. Brett registered their plan for an oceanic or submarine telegraph, and in the same year took out patents for the construction of subterranean lines. In 1847 they obtained permission from the Government of Louis Philippe to establish a submarine cable between the coasts of France and England, but were unable to obtain any support from the public to carry out the undertaking. In 1849 a concession for the same object was granted to them by Prince Louis Napoleon, then President of the French Republic, and in 1851 the Submarine Telegraph Company was formed, and a substantial cable containing four conducting wires, and protected by a coating of iron wires was laid between Dover and Sangatte, near Calais, and this cable is at the present moment in excellent working condition. Mr. John Watkins Brett became afterwards one of the founders of the Atlantic Telegraph, and also of various telegraph lines in the Mediterranean. He died in 1863, leaving only a moderate fortune to be divided among a numerous family of brothers and sisters. Since that time Mr. Jacob Brett, who is now 74 years of age, has fallen into most serious pecuniary difficulties, and at the present moment is absolutely without a home or any means of supporting himself. A committee, consisting of Sir James Carmichael, chairman of the Submarine Telegraph Company, and other gentlemen interested in telegraphic enterprise, has therefore been constituted to promote the subscription of a fund in aid of Mr. Jacob Brett, to which the Submarine Company have given £200, and an appeal is confidently made on his behalf for further assistance to those companies and individuals, as well as to the public in general, who have derived such great benefits from the establishment of the Submarine Telegraph. It must be remembered that if the earlier experiments of Messrs. Brett had ended in failure the world might have been long deprived of that invention which Lord Granville has so happily termed 'the wonderful instrument of communication of thought.'" Messrs. Ransom, Bouverie, and Co., of 1, Pall-Mall East, have kindly consented to receive any subscriptions that may be sent to them for Mr. Jacob Brett's "Benefit Fund."

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HISTORICAL MACHINES.

Soren Hjorth's First Machine.

We have already given some links in the history of magneto and dynamo machines, but hitherto one of the most celebrated of the early machines has not been described in our columns. We have tried to get the specification of this machine, but have always been met with the remark, "out of print." Surely the revenues of the Patent Office are large enough to admit of such specifications being reprinted without loss of time.

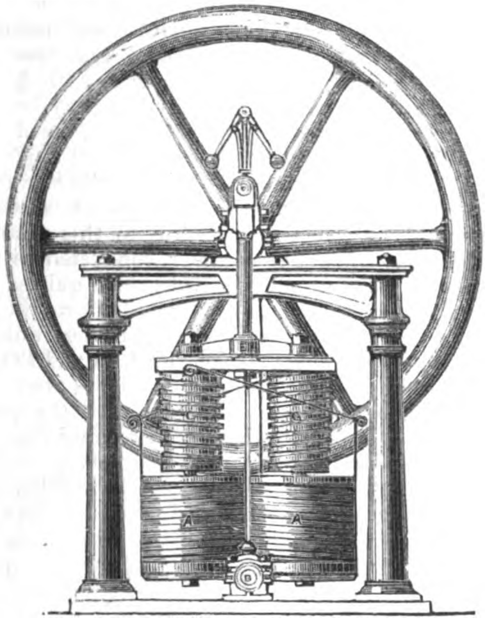


Fig. 1.—Elevation of Hjorth's Engine.

Hjorth described his invention as relating to certain improvements in the use of electro-magnetism, and its application as a motive power for general purposes, also to certain improvements in the application of electro magnetism to

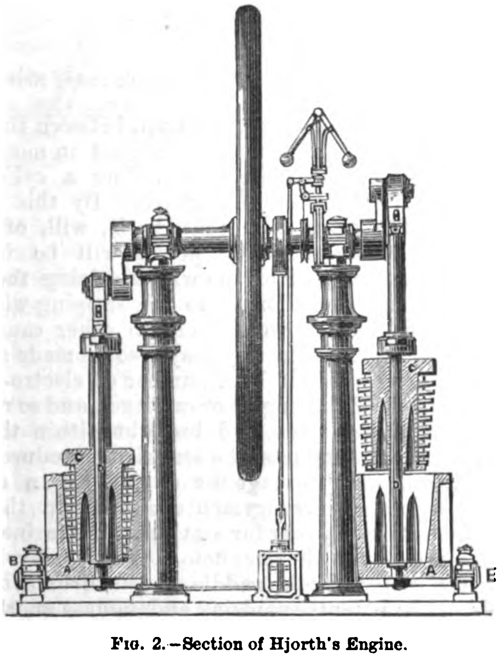
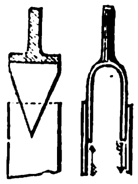


Fig. 2.—Section of Hjorth's Engine.

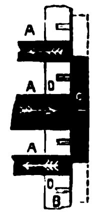
engines, ships, and railways. In the specification the word magnet is used generally to signify either a permanent magnet or an electro magnet. The invention consists in obtaining such power by means of magnets or electro-magnets, both fixed and movable, formed and arranged in such a way that during the motion of the movable magnet, or magnets, separate points or parts of the surface of the movable magnet or magnets, shall be brought successively to act upon, or be acted upon by separate parts of the fixed magnets, so that the attractions and repulsions of one part shall be followed up by the attractions or repulsions of another part, and so a rotatory or reciprocal motion may be obtained over a greater length of stroke or circuit than by the simple action of magnets arranged in the ordinary manner.

Fig. 1 represents an elevation, Fig. 2 a section of one of Hjorth's engines. A A is a horseshoe-shaped hollow magnet, conical on the inside, coiled with copper wire, and suspended so that it oscillates on the centre B, with suitable bearings and plummer blocks as shown. Inside this magnet are fixed a number of conical rods of different lengths. Another horseshoe magnet, C C, is shown, conical outside, with apertures corresponding to the rods in the magnet A A. The magnet C C moves on the guide rods D D connected at the top by the crosshead E, and fastened at the bottom of magnet A A. A connecting rod is attached to C C, driving a fly wheel shaft by cranks in the usual way. A commutator, O, is used similar in its mode of working to the slide valve



Figs. 3 and 4.—Apparatus for Regulating the Current

of a steam engine, and moved in a similar way by an excentric and excentric-rod. The action of the engine may be reversed by the use of a supplemental excentric. The governor serves to regulate the proper supply of current to the commutator as afterwards described. The current from the commutator enters the helix of wires round A A and thence through to the wires of C C, thence through the conducting wires to the battery. As soon as the current passes into the coils they exercise mutual attraction not only in the ordinary way, but in consequence of the magnets being so shaped that the inside part of the outer magnet, as well as the outside part of the inner magnet, form angles with the direction of motion of the moving or the working magnet; and at the same time, rods of different lengths presenting themselves at the poles of the respective magnets, the attractive power is sustained over the whole stroke by successive parts of the surfaces being brought to act upon one another during the whole stroke. When the stroke in this manner has been made by one set of magnets, the current is changed and the other set of magnets are made effec-



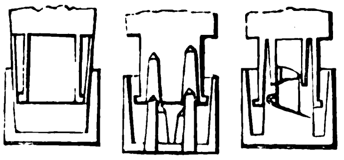


Fig .—The Commutator. Fig . 6, 7, and 8.—Showing various forms of Magnet

tive by the current passing round as previously described. In order to prevent the current being broken, and also to check the momentum of the magnets, the slide in the commutator is made so long that it does not leave the conducting surface, which communicates with one set of magnets, until it has reached the surface communicating with the other set of magnets.

By the arrangement described a reciprocating motion is obtained similar to that of an oscillating steam engine, and the motion can be applied as required by rods, cranks, &c.

Figs. 3 and 4 represent on a larger scale the apparatus for regulating the current. Its action may be understood from the figures. The most convenient form is a forked piece of metal with two wedge-shaped prongs sliding along two parallel surfaces. The current from the battery passes, as indicated by the arrows, from one of the parallel surfaces

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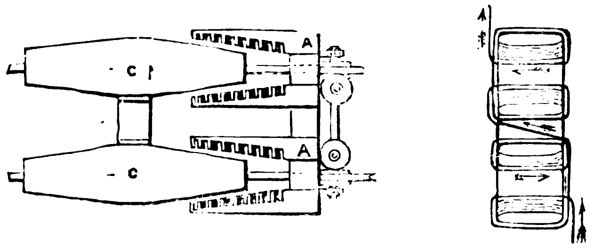
through the fork to the opposite surface, and hence to the commutator, and the current will pass with greater or less intensity according to the amount of surfaces in contact. The particular form is immaterial, so that taper pieces of metal are used, which, by the ordinary action of the governor, may give greater or less communicating surface.

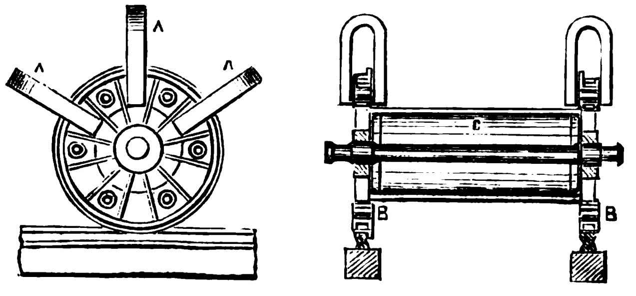
The commutator is shown in Fig. 5 on a larger scale. It consists of three metal surfaces, A, A, A, placed in a non-conducting medium, B. The metal surface, or slide C, is shaped and moved in such a way as to conduct the current according to the motion of the engine alternately from the centre surface, which is connected with the battery to either



FIGS. 9 and 10.—Showing another form of Magnet.

one of the other and outer surfaces, which are connected respectively with the coils of the two sets of magnets. The slide C is made sufficiently long to be always in contact with one or the other surfaces connected with the magnet coils, and by the adjustment of this length and the excentric any required "lead," as it is termed in steam engines, may be obtained. D D is black lead, which may be let into the insulating medium to facilitate conduction, and to act as an anti-friction. The whole apparatus or commutator may be enclosed in an air-tight box, with a glass lid or cover, the slide rod working through a stuffing box. Where large batteries are required for producing sufficient quantity of electricity to work powerful engines, a compound commutator, or several commutators may be employed, each being connected with a certain number of cells, and a certain number of coils. By this means the destruction of the conducting points of the commutator will be avoided, the governor may act so as entirely to detach one or more of the commutators, and so throw off the cells of the battery communicating with such commutators.

Figs. 6, 7, and 8, represent some of the many variations in the form and shape of the magnets, and which may be adopted for the purpose of carrying out my improvements in the use of electro magnetism. In Fig. 6, the coiling of the magnet is surrounded with a sheet-iron casing of a conical



FIGS. 11 and 12.—Showing the method of producing Electricity in an Electro-Magnetic or Common Locomotive.

form, corresponding with the interior of the magnet, in order to obtain a greater attractive surface, and to make the poles of this magnet more effective. Fig. 7 is an enlarged view of the magnets in Fig. 6. In Fig, 8 a long stroke and great attractive surface are obtained by placing a spiral-shaped surface in the interior of the magnet and corresponding grooves or apertures in the magnet. By this arrangement the magnet will act or exercise an attractive power on the successive points of the spiral shaped surface before mentioned, in the same manner as the magnet acts on the rods of different lengths placed in the magnet in Fig. 6. Fig. 9 represents a horse-shoe magnet, each leg of which is divided into two pieces inclined on the inside, and with grooves inside to receive the wires, which are coiled as shown in Fig. 10, the current passing in the direction indicated by the arrows. The magnet is in this case not coiled with wires, being a permanent magnet. The patentee does not confine himself to the use of wrought iron in the magnets or armatures, which may be made of cast iron, or other metals, or substances, which may be made magnetic. It will also be obvious, that the repulsive as well as the attractive powers of metals, or other substances, may be rendered available for the same purposes by means of apparatus constructed and arranged in a manner similar to that herein described. The motive power obtained by the arrangements above described may be employed for all purposes in which power may be required, by the addition of the ordinary apparatus used for such purposes. Thus, the power may be rendered applicable for raising weights, and especially for raising the ram of a pile-engine, or a heavy hammer. In these cases it is intended to apply a magnet, constructed according to this arrangement, immediately over the ram or hammer, connected with it by a web chain or rope, and moving with it in guides. On the side of the frame or guide, adjusting tappets would be fixed, by means of which the connection with the battery would be cut off at any required portion of stroke. Figs. 11 and 12 represent an arrangement by which magneto-electricity is produced in an electro-magnetic or common locomotive, for the purpose of magnetising the wheels, and thereby increasing the adhesion. An are horseshoe-formed permanent magnets, placed so that the inside part of their poles face a certain number of pieces

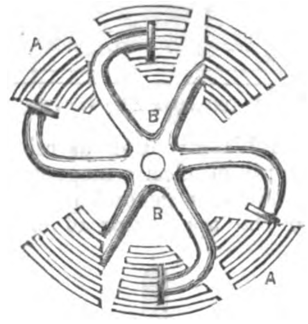


FIG. 13.—Showing an arrangement for obtaining Rotary Motion.

of soft metal, or electro-magnets, B, fixed between the spokes of the wheel. As soon as the wheels are set in motion electricity is induced in the coils surrounding a cylinder, of sheet iron, C, fixed between the wheels. By this arrangement the cylinder, as well as the wheels, will, of course, be magnetic, and the magnetic power will be increased in proportion to the speed of the wheels, giving thereby an increased adhesion proportionate to the slipping which may take place from want of weight or any other cause. The electricity produced in this way may also be made available for moving the engine itself by a number of electro-magnets fixed to the wheels of the engine or carriages, and so revolving by the motion of the train, and brought within the action of fixed permanent magnets, the electricity produced being conducted to the electro-magnetic engine as an auxiliary power. By means of arrangements similar to those just described, an auxiliary power for stationary or marine engines may be obtained from the magneto-electricity developed by the revolution of fly-wheels, paddle-wheels, drums, or working-wheels. The patentee explains and figures another form of commutator, or current changer, as applicable either to the oscillating class of engines or to ordinary reciprocators. To the centre shaft in each set of magnets is attached, at right angles to it, an upright vertical lever, formed with two cross arms, at the end of each of which is placed a syphon cap, similar to those ordinarily used for lubricating purposes. Immediately beneath the discharging tubes of these lubricators, two metallic springs are attached to two pieces of wood, and these springs are adjustable to suit the "lead" required by a set screw, and serve as conductors from the battery to the

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magnetic coil. The two levers and springs act for the back and forward movements of the engine, and each spring is so set that the end of the lever is brought into contact with it just before the engine crank reaches its top centre. By this means the electric current from the battery is conducted from the spring to the levers, and so to the magnetic coil, and the power of the engine is excited for the down stroke on the side in question. A corresponding action takes place in the springs and levers connected with the opposite set of magnets. During the forward motion of the engine, the first spring is kept completely clear of the motion of the lever, by means of a tappet or cam, or any ordinary mechanical arrangement. A corresponding arrangement is adapted to the other spring, and in working the engine the two tappets or cams may be worked by one handle, so that one spring shall be depressed out of the way, and the other released into action, and thus the motion of the engine be reversed. In order to avoid the spark, and to facilitate the communication of the electric current from the springs to the levers, diluted sulphuric acid is constantly allowed to drop from the syphon cups, through the tubes, by means of a wick, to moisten the surface in contact. A similar arrangement being applied on the other side of the engine, and the springs adjusted so that the touching point or surface of the lever on one side of the engine does not leave the corresponding spring before communication is established on the other side of the

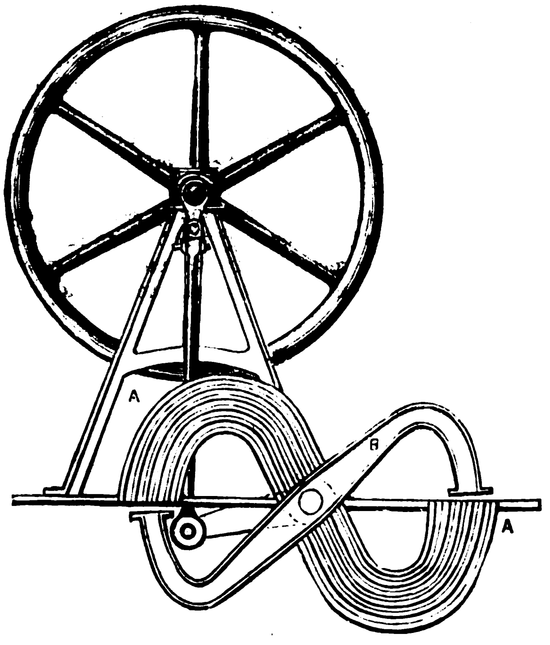

FIG. 14.—Showing method for obtaining Semi-Circular, or Reciprocal, Rotary Motion.

engine, the same result is obtained as has already been described in the other form of commutator. Fig. 13 represents a side elevation of an arrangement by which a rotary motion, with a constant and direct pull, and succession of polarities can be obtained, being one of the modes in which this invention can be applied in and for the construction of a rotary engine. A A are the stationary magnets, here represented as rods of different lengths, put together in such a way that they form a case, with a slit towards the centre for the arms of movable magnets, BB. The said rods are to be fixed in such a way that they do not touch one another, and their ends or surfaces form angles with the direction of motion of the movable magnets. These are to be placed at such a distance from one another, and in such a way that one set of magnets commences to exercise its power before the current passing round or through the other is broken, in order that a constant flow of electricity may be maintained without the current from the battery being broken. The change of the current can be produced by a modification of the common arrangements of a cylinder of metal worked by the shaft, and inlaid with some non-conducting material, from which the conducting wires extend to the coils surrounding the magnets. Fig. 14 shows how a semi-circular motion, or a reciprocal rotary motion, can be obtained, which may be converted into a rotary motion by cranks. A is the stationary, and B the movable magnet. The poles of the stationary magnet form cases, the interior sides of which, or their poles, if built of several bars, form angles with the direction of motion of the movable magnet. In the said cases may be placed rods of different lengths, with corresponding apertures in the movable magnet. The current may be broken in the same way as described in the oscillating engine represented in the engraving. Two sets of magnets will be ordinarily required, working in opposite directions.

Claims.—First: I claim the constructing, arranging, and combining magnets in such a way that they exercise their attractive or repulsive power mutually, by a continuous and direct attraction or repulsion upon points presenting themselves successively during the whole stroke in and for the production of motive power by means of electro-magnetism.

Secondly: I claim the regulating the current of the electric fluid by allowing the same to pass through bodies with surfaces of different dimensions touching or rubbing upon one another in such a way that the areas of the said surfaces are diminished or increased by being moved by a governor, thus allowing a greater or smaller supply of the electric fluid to pass, according to circumstances, in and for the production of motive power by means of electro-magnetism.

Thirdly: I claim the changing the direction of the current by means of a commutator constructed as above described in the use and application of electro-magnetism as a motive power.

Fourthly: I claim the use of electro-magnets adapted to and in combination with engines and carriages on railways, as above described, for the purpose of increasing the adhesion of the wheels, and as an auxiliary power for magnets on railways or stationary and marine engines, as before described.

Fifthly: I claim the arrangements before referred to for producing a rotary motion by a direct pull or thrust, and continual succession of polarities, as above described.

Sixthly: I claim the arranging and combining magnets constructed as described, so that a semi-circular motion or a reciprocal rotary motion of the movable magnet may be obtained, and the power transferred thence, either directly to the work or through cranks and connecting rods, to a revolving shaft.

Lastly: I claim the combining the several arrangements before described and referred to for the application of electricity as a motive power to engines, ships, and railways.

THEORY OF MAGNETO AND DYNAMO MACHINES.

XVII.

It is now time to discuss the rotation of an actual armature in a magnetic field, and we will for this purpose select the Siemens to begin with. It is usual to consider the Gramme as the simplest form of armature, and certainly its construction and mode of action is very easily intelligible; while Von Hefner Alteneck's ingenious method of winding the Siemens armature is understood by comparatively few. Nevertheless, the theory of the Siemens is in one important respect simpler than that of the Gramme, viz., that its core of iron, though helpful, is not necessary; while the iron in the Gramme, as in the old Pixii, Clark, and Saxton machines, is an absolutely indispensable condition of its action.

Now the introduction of iron into the theory, though it must be made at a later stage, is best deferred, because all manner of secondary and complicated actions are with it introduced, unless indeed the iron may be regarded as perfectly non-conducting and infinitely "soft."

A method of classifying the numerous machines of the present day is much needed, but, as is the case with other

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subjects, the best system of classification depends upon what its object is.

The historian would try to arrange them in order of development, something after the fashion of a family tree, so as to enable their relationships, and the ways in which they shade off into one another, to be traced; and this would be an extremely useful, though somewhat controversial and invidious method.

The common rough and ready system is to divide them into magneto and dynamo; continuous and alternating. But these divisions are too obvious to need further insisting on.

The shareholding public classify them according to the companies who respectively possess them, and according to their market value. The inventors, we suppose, have the simple, satisfactory, and exhaustive classification, into—mine and other people's.

For our present purpose we require a purely scientific arrangement, and we will try how it answers to divide them first into two classes—those which essentially require iron in their armatures, and those which do not. A further bifurcation may be made by arranging them into those which will work in a simple uniform magnetic field, like the earth's, and those which require a more complex and artificial arrangement of magnets. The high E.M.F. and alternating machines mostly come under this latter head.

There is no need to express an opinion as to the *à priori* merits of the four columns so obtained—each has advantages for particular purposes—nevertheless, just as we consider that the great improvement of Siemens's old armature over the Clark and Saxton form was the shaping and arranging it in such a way that its iron core was a useful auxiliary instead of a necessity, so we hold that any machine in which iron is an essential requisite has the burden of proving that it is a better machine than one which is able to do without it. But we do not assert that it could not make out a good case. For instance, the De Meritens is an undoubted improvement on the Holmes-Alliance.

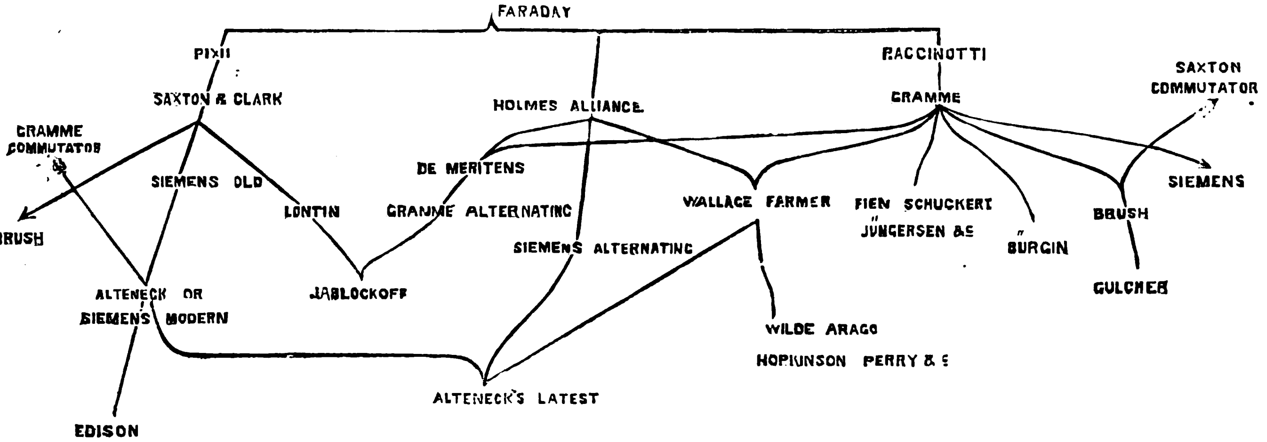
The following table, considered as a list of machines, does not pretend to be complete; it contains most of the better known ones, but it may easily be extended by anybody who will take the trouble to write the names of additional machines in their appropriate columns:—

Classification of Magneto and Dynamo Machines.

Machines which will work in a simple uniform magnetic field.		Machines which require a more complex arrangement of field magnets.	
Machines which can act without an iron core in their armatures.	Machines in whose armatures iron is essential.	Machines which can act without an iron core in their armatures.	Machines in whose armatures iron is essential.
Faraday's original copper disc. Siemens's old form. Siemens's modern. Lontin. Edison.	Pacinotti. Gramme. Brush. Bürgin. Fein. Schuckert. Jürgensen. Gülcher.	Holmes-Alliance. Wallace-Farmer. Wilde. Siemens's alternating. Arago. Hopkinson and Muirhead. Perry. Von Alteneck's newest form.	Pixii. Saxton and Clark. De Meritens. Gramme alternating. Jablochkoff.

Of course the division into "continuous current" and "alternating" remains as a fundamental one, but the division into "magneto" and "dynamo" is scarcely of so much importance, for any continuous current machine may be made self-exciting, and no alternating machine has yet been made so. The division again into shunt dynamos and ordinary dynamos is a mere detail, though undoubtedly it is of great practical importance, and though the theory of the two is considerably different. The alternating machines in the above list are: Holmes, De Meritens, one Siemens, one Gramme, one Lontin, one Hopkinson, and Jablochkoff; and all these are necessarily "magneto," in the sense that they either use permanent magnets or require a separate exciter. The others are continuous current machines, and are usually self-exciting. It is a question whether the Gülcher ought not to go into the fourth column instead of the second, but it seems a pity to separate it from its congeners on account of a mere doubling of the parts.

Table of Affinities of Magneto and Dynamo Machines.



The above table sometimes fails to show the relationships between the different machines, and if we venture to draw up another with this object, it is with a proper sense of the difficulty of the task, and the considerable chances of error and incompleteness. However, here is an attempt. It is supposed to be wrapped round a cylinder, in order to avoid too great crossing of the lines of relationship. These lines, it must be remembered, do not assert parentage; they merely imply a sufficient likeness to justify a presumptive relationship without evidence to the contrary.

(TO BE CONTINUED.)

VAN RYSSELBERGHE'S TELEPHONIC SYSTEM.

We recently alluded to the fact that M. Van Rysselberghe, head of the Meteorological Observatory at Brussels, had succeeded in sending a telephonic message over a long length of ordinary telegraph wire at the same time that a telegraphic message was being sent over the same wire, and that both messages had been distinctly received. Our contemporary, *La Nature*, recently published an account of the way in which M. Van Rysselberghe overcomes the effects of induction, from which we extract the following particulars:—Fig. 1 represents a telegraph and telephone line running parallel to one another, with the ends of the wires to earth, as in ordinary telegraph lines. Each time that the key M is depressed a current is sent to line, which is almost instantaneously charged, all neighbouring wires—and in this particular case the telephone wire—are traversed by a strong induction current of short duration. The same phenomenon

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occurs, but in an inverse sense, when the circuit is broken. This series of strong induction currents of short duration produces in the telephones a kind of crackling, or frying noise (*friture*), which is the more objectionable the more telegraph wires there are, up to a point when receiving is often impossible.

Supposing that we can, by some method or other, graduate the induction current, so that it shall only attain its full strength bit by bit, the induced currents developed in the telephonic circuit will be prolonged over a longer period, but will be less intense. The action on the receiving diaphragm will also be progressive, and will produce scarcely any sound at all. In fact we shall have replaced violent and instantaneous attraction by a series of weak and successive impulses. To weaken the electric wave of induction, and to suppress the crackling noise produced thereby if not weakened, M. Van Rysselberghe employs various methods. We shall describe two of these which have given good results.

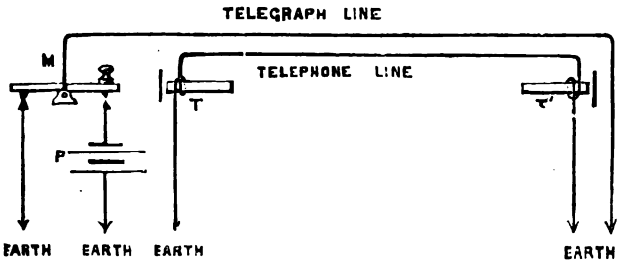

Fig. 1.—Connections of a Telegraph and Telephone Line, showing the cause of induction.

One of them consists in employing keys provided with adjustable rheostats arranged so that when the key lever is depressed there are introduced into the circuit, between the battery and the line, resistances varying progressively from infinity to zero. These rheostats are constructed of mediocre conductors, on which rubs a brush fixed to the key lever. The line is thus charged bit by bit, and comparatively slowly, since the intensity of the current varies with the resistance interposed during the depression of the key lever, and the effects of induction are not sufficiently strong to interfere with telephonic transmission. This transmission on a distinct circuit can be carried on either by means of magneto telephones, battery telephones, or microphonic transmitters.

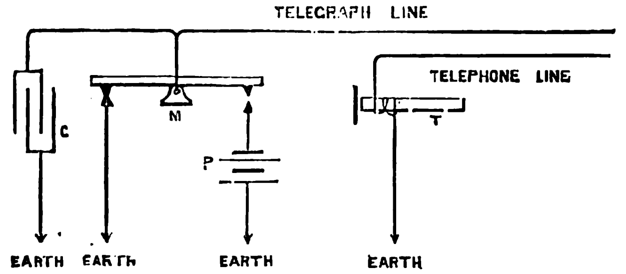

Fig. 2.—Connections of a Telegraph Line, with Condenser, in a shunt circuit, in order to overcome the effects of induction in the Telephone Line.

A second method employed by M. Van Rysselberghe allows of the suppression of induction without in any way altering the arrangement of the key lever. It consists in placing a condenser, C (Fig. 2), in a shunt circuit, as shown. At the moment when the circuit is closed, the electric flow divides between the condenser and the line; this latter, therefore, only takes its charge progressively. The desired result is also obtained in a certain degree by combining the two methods; that is to say, the key with variable resistances and the condensor in a shunt circuit. By this means the effects of induction are quite overcome. It is this combination which gives the best results in practice.

In addition to the above described methods of overcoming induction, M. Van Rysselberghe has introduced several improvements into his telephones which enable him to transmit over long distances. We shall hope to be able to illustrate his apparatus before long.

In the above figures the letter P stands for battery and T for telephone.

ON THE GRADUATION OF GALVANOMETERS FOR THE MEASUREMENT OF ELECTROMOTIVE FORCES AND CURRENTS IN ABSOLUTE MEASURE.

BY THOMAS GRAY, B.SC., F.R.S.E.

Recent developments in the applications of electricity have rendered a class of instruments necessary which were previously seldom required, namely, instruments for the purpose of measuring in absolute units the quantity of electricity flowing through an electric circuit, and the electromotive force producing that current. Having been engaged in determining the constants necessary for the graduation in absolute measure of Sir William Thomson's new galvanometers, it has occurred to me that a discussion of one or two of the methods which may be followed in such a case may be interesting and useful to some of the readers of *The Electrician.*

As is well known, the value of the indications of a galvanometer depends on the intensity of the magnetic field in which the needle is placed, on the current flowing through the coil, on the shape, size, and number of windings in the coil, and on some function of the angle through which the needle is deflected. In order, therefore, that the value in absolute units of the indications of a galvanometer may be estimated, we require to determine in the same units the intensity of a magnetic field, and, either separately or as a whole, the value of the different elements depending on the coil. We will employ in the calculations of this article the centimetre as the unit of length, the gramme as the unit of mass, and the second as the unit of time.

With regard to the magnetic field it is generally convenient to use, as our standard at least, the horizontal intensity of the earth's magnetic field at the place of experiment, this being more uniform, and consequently more easily determined than any artificial field we can readily produce. Let us begin, then, by determining in C G S units the intensity of the horizontal component of the earth's magnetic force. The following method will be found sufficiently accurate for almost any purpose, and at the same time easily used. Manufacture three or four small magnets, say ten centimetres long and one millimetre in diameter, out of glass-hard tempered steel wire. Measure accurately the length in centimetres and the weight in grammes of each of these magnets. Suspend one of them within a glass shade by means of a single silk fibre about thirty centimetres long, so that its magnetic axis is nearly horizontal. The easiest way to manage this is to form a double loop on the end of the silk fibre and place the magnet within these two loops in such a manner that the loops and magnet form the three sides of a triangle. When this method is adopted the calculations are not complicated by the inertia of a supporting cradle, the one used being practically massless. Draw a fine line on the sole plate on which the shade stands and set up a fine vertical mark at the end of this line nearest the observer. A fine line scratched on the glass, for instance, serves very well for this purpose. Turn the sole plate and shade round until the magnet hangs exactly in the plane of these two lines, and then deflect the magnet slightly by bringing another magnet forward towards it, taking care to keep its length at right angles to the length of the suspended magnet, and in a line passing through the centre of that magnet. If this precaution is not attended to the suspended magnet gets up a pendulum swing, which interferes with our observations. When the amplitude of vibration reaches about five degrees note the time at which the magnet crosses its position of equilibrium as marked by the vertical and horizontal lines just described. Again note the time at which the magnet crosses the same position, after, say, ten complete vibrations, and again after twenty and thirty, until the amplitude of vibration becomes too small to allow of the exact instant of crossing to be accurately observed. These separate observations will form a check on each other, and the total interval between the first observation and the last divided by the number of complete periods will give the period of one vibration. By a complete vibration is meant a swing from the centre to one side, then back to the other side, and then to the middle again. Repeat this experiment until each suc-

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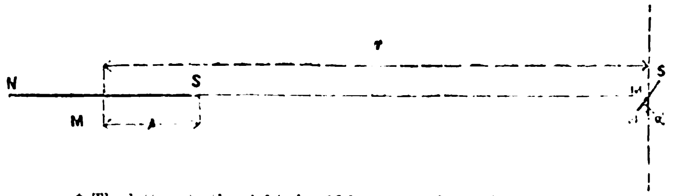
cessive experiment gives very nearly the same result. Irregularities are certainly due to errors of observation, and hence irregular results must be discarded. The time may be taken by means of a good watch, and it is better to have a second observer for this purpose. An expert observer will take time to the tenth part of a second, especially if provided with a watch having a centre-seconds hand, and the dial divided to quarter seconds. None of the contrivances for stopping and starting a watch, or for marking on the dial are to satisfactory as single observation, accuracy in which can be readily acquired by a little practice. Repeat this experiment with each of the magnets. The reason why separate magnets are recommended for the different experiments is that errors in the measurement of length and mass are thus to some extent eliminated. Of course no account is here taken of the very small, but in certain circumstances necessary for air friction, change of inertia due to air dragged along with the magnet, want of perfect flexibility in the fibre, and possible changes of magnetic moment, due to slight changes of temperature during the observations. Next place in the position where the needles were vibrated a magnetometer, which had better consist of a very short, light magnetic needle, rigidly fixed to a light mirror, and suspended by a single silk fibre, as in Thomson's reflecting galvanometer. Arrange a scale in front of the mirror, and, if convenient, at a distance of one metre from it. The deflection of the mirror on one side or other of its position of equilibrium may be observed by means of this scale either by a beam of light from the mirror focussed on the scale, as is usual with Thomson's instruments, or by observing the reflection of the scale in the mirror by means of a telescope. Having completed these arrangements, observe the zero position of the mirror, and then place at a measured distance from the magnetometer

FIG. 1.*



* The letters to the right should be *m*, *n*, *s*, instead of M, N, S.

needle one of the magnets which were vibrated, the direction of the axis of the magnet being at right angles to the magnetic meridian, and the centre of the axis either vertical above or below the centre of the needle, or due north, south, east, or west of it. Observe, now, the angle through which the magnetometer needle has been turned, then reverse the positions of the ends of the magnet, and again observe the deflection from zero of the magnetometer needle. Make a similar pair of observations with the magnet on the opposite side, and at the same distance from the magnetometer needle, and take the mean of the four observations, and half the distance between the two positions of the centre of the magnet as the deflection and distance respectively. It must be borne in mind that the angle turned through by the needle is half the angle turned through by the beam of light reflected from the mirror. As to the best relative positions of the magnetometer needle and deflecting magnet it may be remarked that the most symmetrical position is when the centre of magnet and needle are in the same vertical line. The next best, and generally more convenient, position is when the magnet is east or west of the needle, and this is the position adopted in the calculations given below, and illustrated in Fig. 1.

In this figure m represents the magnetometer needle and M the deflecting magnet, placed with its centre at a distance, r, from the centre of the needle m, the length of the magnet being supposed equal to $2a$, and the angle through which it deflects m equal to α. If it is inconvenient to measure the angle α by means of a mirror, and great accuracy is not required, a light index may be attached to the needle and its deflection observed on a graduated scale placed beneath it. The angle α is to be observed for each of the magnets which were vibrated, and then from each set of observations a value of H, the horizontal component of the earth's magnetic force, calculated. If the different values of H thus found are nearly the same, then the mean will probably closely approximate to the true value. The calculation is made in the following manner:—

First from vibration:—

Let H = the horizontal component of the earth's magnetic force.

M = the magnetic moment of one of the magnets experimented on.

T = its period of vibration.

$2a$ = its length in centimetres.

w = its weight in grammes.

μ = its moment of inertia round the suspending fibre.

θ = its inclination at any instant to the magnetic meridian.

We have then the angular acceleration towards its position of equilibrium in the magnetic meridian equal to the moment of the return couple acting on it divided by the moment of inertia μ of the magnet, or in symbols

$$\frac{d^2\theta}{dt^2} = -\frac{\mathrm{M\,H}}{\mu}\sin.\theta.$$

Now, since we have only to do with small values of θ, we may put sin. $\theta = \theta$, and we get the much simpler equation

$$\frac{d^2\theta}{dt^2} + \frac{\mathrm{M\,H}}{\mu}\theta = 0.$$

The integral of this equation is

$$\theta = \mathrm{A}\cos.\left(\sqrt{\frac{\mathrm{M\,H}}{\mu}}\,t - \mathrm{B}\right),$$

which represents an oscillatory motion of amplitute A and period $2\pi\sqrt{\frac{\mu}{\mathrm{M\,H}}}$.

Hence $\mathrm{T}^2 = \frac{4\pi^2\mu}{\mathrm{M\,H}}$, and therefore,

$$\mathrm{M\,H} = \frac{4\pi^2\mu}{\mathrm{T}^2}. \quad \ldots\ldots \quad (1)$$

Second, by deflection, see Fig. 1:—

Let α = the deflection of the magnetometer needle.

f = the strength of one pole of the needle.

l = the length of the needle.

F = the strength of one pole of the magnet M.

$2a$ = its length.

r = the distance of its centre from the centre of the needle.

Then

$$\mathrm{F}f\left\{\frac{1}{(r-a)^2} - \frac{1}{(r+a)^2}\right\} l\cos.\alpha = \mathrm{H}f\sin.\alpha.$$

$$\because \quad \frac{4\,\mathrm{F}\,a\,r}{(r-a)^2\,(r+a)^2} = \mathrm{H}\tan.\alpha.$$

Now $2\,\mathrm{F}a = \mathrm{M}$; hence

$$\frac{2\,\mathrm{M}\,r}{(r+a)^2\,(r-a)^2} = \mathrm{H}\tan.\alpha,$$

or

$$\mathrm{M} = \frac{(r-a)^2\,(r+a)^2\,\mathrm{H}\tan.\alpha}{2\,r}.$$

Substituting this value of M in equation (1), we get

$$\mathrm{H}^2 = \frac{8\pi^2\mu\,r}{\mathrm{T}^2\,(r-a)^2\,(r+a)^2\tan.\alpha}. \quad .\;.\;(2)$$

Since the length of the magnet is supposed great in comparison with its thickness, μ will be nearly enough equal to $\frac{1}{3}wa^2$; hence we obtain finally

$$\mathrm{H} = \frac{\pi\,a\sqrt{8\,w\,r}}{\mathrm{T}\,(r-a)\,(r+a)\sqrt{\tan.\alpha}}.$$

(TO BE CONTINUED.)

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FIRE RISKS FROM ELECTRIC LIGHTING.

The following rules and regulations for the prevention of fire risks arising from electric lighting have been recommended by the Council of the Society of Telegraph Engineers and of Electricians, in accordance with the report of the committee appointed by them on May 11, 1882, to consider the subject:—

The members of the committee were—Professor W. G. Adams, F.R.S, vice-president; Sir Charles T. Bright, T. Russell Crampton, R. E. Crompton, W. Crookes, F.R.S.; Warren De la Rue, D.C.L., F.R.S.; Professor G. C. Foster, F.R.S., past president; Edward Graves, J. E. H. Gordon, Dr. J. Hopkinson, F.R.S.; Professor D. E. Hughes, F.R.S., vice-president; W. H. Preece, F.R.S., past president; Alexander Siemens, C. E. Spagnoletti, vice-president; James N. Shoolbred, Augustus Stroh, Sir William Thomson, F.R.S., past president; Lieut.-Colonel C. E. Webber, R.E., president.

These rules and regulations are drawn up not only for the guidance and instruction of those who have electric lighting apparatus installed on their premises, but for the reduction to a minimum of those risks of fire which are inherent to every system of artificial illumination. The chief dangers of every new application of electricity arise mainly from ignorance and inexperience on the part of those who supply and fit up the requisite plant. The difficulties that beset the electrical engineer are chiefly internal and invisible, and they can only be effectually guarded against by "testing" or probing with electric currents. They depend chiefly on leakage, undue resistance in the conductor, and bad joints, which lead to waste of energy and the production of heat. These defects can only be detected by measuring, by means of special apparatus, the currents that are, either ordinarily or for the purpose of testing, passed through the circuit. Bare or exposed conductors should always be within visual inspection, since the accidental falling on to or thoughtless placing of other conducting bodies upon such conductors might lead to "short circuiting" or the sudden generation of heat due to a powerful current of electricity in conductors too small to carry it. It cannot be too strongly urged that among the chief enemies to be guarded against are the presence of moisture and the use of "earth" as part of the circuit. Moisture leads to loss of current and to the destruction of the conductor by electrolytic corrosion, and the injudicious use of "earth" as a part of the circuit tends to magnify every other source of difficulty and danger. The chief element of safety is the employment of skilled and experienced electricians to supervise the work.

I. The Dynamo Machine.

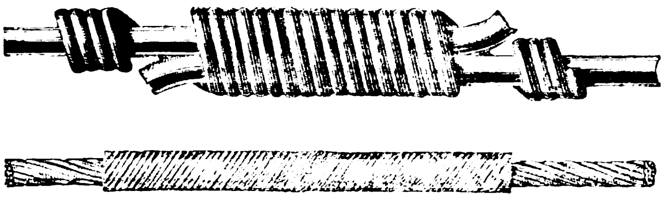
1. The dynamo machine should be fixed in a dry place.
2. It should not be exposed to dust or flyings.
3. It should be kept perfectly clean and its bearings well oiled.
4. The insulation of its coils and conductors should be perfect.
5. It is better, when practicable, to fix it on an insulating bed.
6. All conductors in the dynamo room should be firmly supported, well-insulated, conveniently arranged for inspection, and marked or numbered.

II. The Wires.

7. Every switch or commutator used for turning the current on or off should be constructed so that when it is moved and left to itself it cannot permit of a permanent arc or of heating, and its stand should be made of slate, stoneware, or some other incombustible substance.
8. There should be in connection with the main circuit a safety fuse constructed of easily fusible metal which would be melted if the current attain any undue magnitude, and would thus cause the circuit to be broken.
9. Every part of the circuit should be so determined that the gauge of wire to be used is properly proportioned to the currents it will have to carry, and changes of circuit, from a larger to a smaller conductor, should be sufficiently protected with suitable safety fuses, so that no portion of the conductor should ever be allowed to attain a temperature exceeding 150 deg. F.

N.B.—These fuses are of the very essence of safety. They should always be enclosed in incombustible cases. Even if wires become perceptibly warmed by the ordinary current, it is a proof that they are too small for the work they have to do, and that they ought to be replaced by larger wires.

10. Under ordinary circumstances complete metallic circuits should be used, and the employment of gas or water pipes as conductors for the purpose of completing the circuit should in no case be allowed.
11. Where bare wire out of doors rests on insulating supports it should be coated with insulating material, such as india rubber, tape, or tube, for at least two feet on each side of the support.
12. Bare wires passing over the tops of houses should never be less than seven feet clear of any part of the roof, and they should invariably be high enough, when crossing thoroughfares, to allow fire escapes to pass under them.
13. It is most essential that the joints should be electrically and mechanically perfect. One of the best joints is that shown in the accompanying sketches. The joint is whipped around with small wire and the whole mechanically united by solder.
14. The position of wires when underground should be efficiently indicated, and they should be laid down so as to be easily inspected and repaired.
15. All wires used for indoor purposes should be efficiently insulated.
16. When these wires pass through roofs, floors, walls, or partitions, or where they cross or are liable to touch metallic masses like iron girders or pipes, they should be thoroughly protected from abrasion with each other or with the metallic masses, by suitable additional covering; and where they are liable to abrasion from any cause or to the depredations of rats or mice, they should be efficiently encased in some hard material.
17. Where wires are put out of sight, as beneath flooring, they should be thoroughly protected from mechanical injury, and their position should be indicated.



N.B.—The value of frequently testing the wires cannot be too strongly urged. It is an operation skill in which is easily acquired and applied. The escape of electricity cannot be detected by the sense of smell as can gas, but it can be detected by apparatus far more certain and delicate. Leakage not only means waste, but in the presence of moisture it means destruction of the conductor and its insulating covering by electric action.

III. Lamps.

18. Arc lamps should always be guarded by proper lanterns to prevent danger from falling incandescent pieces of carbon, and from ascending sparks. Their globes should be protected with wire netting.
19. The lanterns and all parts which are to be handled should be insulated from the circuit.

IV. Danger to Person.

20. To secure persons from danger inside buildings, it is essential so to arrange the conductors and fittings that no one can be exposed to the shocks of alternating currents exceeding 60 volts; and that there should never be a difference of potential of more than 200 volts between any two points in the same room.
21. If the difference of potential within any house exceeds 200 volts, whether the source of electricity be external or internal, the house should be provided outside with a "switch," so arranged that the supply of electricity can be at once cut off.

By order of the Council,

F. H. Webb, Secretary.

Offices of the Society, 4, The Sanctuary, Westminster,
June 21, 1881.

Eastern Telegraph Company.—This company announce that, subject to the final audit, the accounts show, after placing the sum of £75,000 to the reserve fund, a balance available for dividend which will enable the directors at the general meeting to pay the fixed dividend of 3s. per share, being at the rate of 6 per cent. per annum, on the preference shares, and recommend the payment of a final dividend of 2s. 6d. per share, with a bonus of 1s. per share, on the ordinary shares, both free of income-tax, making with previous payments on account a dividend for the year ending the 31st of March, 1882, of 5½ per cent. on the ordinary shares, and carrying forward a balance of about £1,000. The next meeting of this company will take place at the Cannon-street Hotel on the 13th July, at 2 p.m. The report will be found in another column.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 396, Strand, London, W.C.

All letters intended for insertion in THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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THE INLAND TELEGRAPH SERVICE.

The promulgation of a revised classification for the maintenance, or engineering, branch of the Post Office Telegraph Service, now officially announced, is, we believe, the last word of the Treasury in answer to the demands made upon it some two years ago. The members of the engineering branch did not to any considerable extent join in the agitation for re-classification, and as a reward for their moderation they have been served last. Our present information, however, goes to show that, on the whole, the claims of the technical department, though longest delayed, have been fairly considered, and with results that are generally satisfactory. An exception in respect to linemen, who, we understand, get nothing, is to be regretted; but is perhaps intelligible on the ground of their being unskilled workmen whose places can always be filled on the spot without difficulty. This, at least, is the only explanation we can suggest for their being left out in the cold. Whether the workmen themselves will consider it a sufficient reason for continued abstentation from combination and agitation on their own account is another matter. The rest appear to be satisfied, and, for the present at least, all seems quiet in that quarter.

As much cannot be said apparently for the general body of the working staff. In our last issue we gave an account of a meeting held in London on the previous Sunday, which showed that a twelvemonth's trial of the scheme devised for their benefit has failed to give satisfaction to the telegraph clerks. "The Annual Conference of the Postal Telegraph Clerks' Association"—which was the designation of the meeting to which we refer—is, perhaps, more formidable in sound than in fact; but, taken in connection with a number of meetings of a similar kind, and with letters in the newspapers—which have hardly ceased their importunities since the scheme was first issued—this meeting in the metropolis cannot be lightly passed over. We sincerely hope that a like fate does not await the classification for the engineering staff; for if such were the case, after its operation has been looked into more carefully, there will be little chance of peace for the service as a whole. A combination among the aggrieved of both sections would bring about as threatening a state of things as prevailed in 1880. Undoubtedly the authorities managed adroitly enough to break up the combination of that year by rewarding secession from its ranks, and withholding reward from the refractory. This is a policy which averts serious danger; but, unhappily, it also serves to intensify discontent. It diminishes the area, but increases the bitterness of the conflict. No possible classification could have given satisfaction to all parties; but any classification that leaves a considerable section of the *employés* in the ranks of the disaffected, as that of 1881 appears to have done, must be defective somewhere, either in principle or application.

As nothing has latterly been said about promotions being arbitrarily withheld where they have been officially sanctioned, we may assume that the scheme as framed for the telegraph operators has at length been applied all round, and that the men know exactly what they can claim and what they may look forward to. Classification is what the Telegraph Clerks' Association appear to quarrel with. It is true that the first resolution expresses strong dissatisfaction "at the unjust and partial manner" in which the scheme has been applied; but as the scheme itself must have left an opening for this form of application—supposing it to have been practised—the scheme, and not the administration, bears all the blame. The resolution further protests against "the inadequacy of the scheme of revision," and concludes by expressing its "indignation that while the scheme ostensibly confers benefits, however small, those benefits are to a large extent diminished by the system of classification which is still retained." A sentence, beginning with indignation and ending with classification which is still retained, besides being flat, is bewildering. One would have expected the indignation to be reserved for those local authorities who are implicitly accused of applying the scheme in a partial manner; but, unless we are to take it that the epithets grow stronger as the offences get milder, we are driven to the conclusion that partiality and unfairness are as nothing compared with the system of classification which is still retained. Here again we are at a loss to know whether it is the system or the continuance of it that arouses indignation. If they object to any sort of classification these delegates should say so; nay, they should have said so before the old classification was succeeded by an amended one of the same order. We have on former occasions pointed out the objections to classification as it prevails in the Civil Service—a system which is, moreover, opposed to all the traditions and usages of the old telegraph companies. Those objections are many and sound, but they are not likely to be heeded in a service where classification is the basis of the entire organisation. Nor do we think that the new race of telegraph clerks would be benefited by the abolition of

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classification in deference to their prejudice. When fixity of location has become the rule, and not, as in former times, the exception, classification of some kind is indispensable in the interests of the clerks themselves, who would otherwise very speedily experience the pinch of fixity of wages. No sensible man, however, quarrels with a classification which classifies him comfortably; and we may, therefore, not uncharitably assume that what the conference are indignant about is that they have fared badly under the classification as it is, not that any kind of classification is "still retained."

The next resolution is of more mysterious import. The conference are of opinion that an inquiry by a Select Committee of the House of Commons into the administration of the Telegraph Department is necessary in the best interests of the service. "In the best interests of the service" is, perhaps, a mere rhetorical flourish, pardonable in the circumstances of a conference claiming to pass resolutions "on behalf and at the desire of the postal telegraph clerks of the United Kingdom;" but, while declining to endorse the declaration that such an inquiry is necessary, we are certainly disposed to think that it might be useful. For one thing we should learn exactly what the Association really desire. Their resolutions are, if we may be pardoned for saying so, exceedingly mixed. If there are specific local wrongs, surely they can be remedied by energetic local action better than by innuendoes at a London tavern; and if the classification works out badly in practice, its radical errors can be pointed out without accusing it of ostensibly conferring benefits which it knows to be illusory. We do occasionally hear of parliamentary committees at work, though we have almost forgotten what parliamentary Acts are like; and an investigation before such a body would probably settle this vexatious agitation once for all. If the Department wants to do justice, as no doubt it does, it has nothing to fear; and if the clerks, or the Association on their behalf, can draw up a substantial case for such a committee, we should be inclined to take them at their word. Facts, however, that will bear rigorous investigation would have to be adduced on an occasion of that sort; and much as we sympathise with the individual cases of hardship which have, no doubt, occurred in dealing with the claims of so numerous a body, we have as yet seen no evidence deserving of the name to warrant the sweeping condemnations which find their way, unsifted and unauthenticated, into newspaper columns, or in the cut-and-dried resolutions passed at conference meetings—none, at least, which would pass the ordeal of a cross-examination at Westminster. The third and concluding resolution had reference to the grievances of pre-transfer clerks, but we must reserve our remarks upon this subject for another occasion.

SUBMARINE CABLES.

The accidents which occurred last summer to various cables radiating from England to the Continent, the knowledge that some of these accidents were caused by wilfulness, and others by gross carlessness, led the Cable Companies to communicate with the Board of Trade on the subject. Previously to this many complaints had been made as to the suitability of lights used by cable ships, these being similar to distress lights, and frequently leading to confusion. The representations made by the companies have resulted in certain improvements, which will, no doubt, be appreciated. The signals have already been revised, and it will be seen from a communication, given elsewhere, from the Board of Trade to Mr. J. Pender, M.P., a definite statement is made that there is a legal remedy for the Cable Companies in case of wilful damage. It is, of course, necessary that other governments as well as the English should concur in assisting to maintain the inviolability of cables from wilful damage, and although the negotiations are not yet concluded, as will be seen from the last clause of the letter previously mentioned, we believe that the governments communicated with are in practical agreement on the question.

CORRESPONDENCE.

WHAT IS ELECTRICITY?

Temperature.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The object of my present paper is to show the mode in which the force of the sun is productive of change of temperature, and effects the expansion of bodies under low as well as high temperatures.

1. It is well known that the heat of the sun does not really reach the earth, for even in the tropics the snow mountains—which are points on the earth's surface most exposed to the sun's influence—are, of course, many degrees lower in temperature than the valleys beneath; and, again, observations made during balloon ascents prove that temperature diminishes as altitude increases.

2. I have stated that the fact is well known that the heat of the sun is not transmitted as heat to the earth; but yet a degree of obscurity on this point appears to exist, which, in one way or another, ought to be removed, for a very able compiler of sun facts—Dr. Young—states that "all waves of solar radiation are carriers of energy, and, when intercepted, do work, producing heat, or vision, or chemical action, according to circumstances." But he immediately adds, "If the amount of solar light is enormous, as compared with terrestrial standards, the same thing is still more true of solar heat, which admits of somewhat more accurate measurement, since we are no longer dependent on a unit so unsatisfactory as the 'candle-power,' and can substitute thermometers and balances for the human eye."

3. The first statement appears to regard rise of temperature on the earth's surface as due to the energy of the sun; the latter, as I interpret the words to mean, conveys that we are able to measure the heat which the sun transmits as heat to the earth. But, whether my construction of the passage be right or wrong, it is evident that no ambiguity should exist upon this very important point.

4. In my letter upon the mode of transmission of the imponderables, and more especially on the propagation of light, I pointed out that the force which is given out as magnetic force over every portion of the earth's surface takes a helical direction in accordance with the laws of magnetism, and that the lines of force which reach the earth from the sun are disposed in like manner. I also showed by the laws of motion that the helices increase in a given space with the resistance or density of the matter.

5. In my letter on universal gravitation I have shown that vortices of force are generated by the motion of the earth, in common with the motion of the celestial bodies, owing to their motion imparting a like motion to the medium in which they rotate.

6. We may in a measure judge of the effects of this motion of the celestial bodies upon the matter surrounding them more immediately, as well as the matter in interplanetary space, by rotating a well weighted orange in a large glass jar of water. The motion of the orange will impart motion to the whole of the water, and this motion will be continued in spite of the friction of the sides of the jar, &c., long after the orange has ceased to move. Now, when we consider the effects of such motion of the orange upon the matter in which it is immersed, and compare it with the motion of the mass of one of the celestial bodies, and bear in mind the high rate

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of motion of the latter, its incessant character, and the indestructibility of the momenta or waves, and yet further, the little resistance the attenuating medium offers to the transmission of these waves of motion, we can form some slight estimate of the degree and character of the motions which the celestial bodies propagate to the medium in which they move, and to each other.

7. It is a well known fact that the rays of the sun are productive of increase of temperature in proportion as they are more or less direct, and that expansion occurs in bodies under heat, and in some, probably in all, under cold also.

8. The cause of this expansion under heat is attributed to the property heat possesses as a force of repulsion; but why increase of temperature should act in such manner has not that I am aware of been shown; much less has it been determined why bodies expand under the influence of cold.

9. I now hope to prove conclusively why the direct rays of the sun's helical force cause density to be diminished and temperature to be increased; why density is increased and temperature reduced under the oblique rays of the sun as the poles of the earth are approached; and why bodies expand again at a low temperature.

10. First, with regard to the production of increase of temperature, and the expansion of matter under the direct application of the force of the sun.

The mechanical effects of the force of the sun and the force of the earth in the elevation of temperature and the expansion of the matter acted upon may be readily illustrated in the following simple but effective manner.

Take eight or ten pieces of stout cord, such as is used for window blinds, about five inches in length. Lay them side by side, and then tie some fine twine tightly round the ends; they will thus form one cord, the strands of which are loose. A helical character may be imparted by twisting one end to the right and the other to the left. The strands of the cord being expressive of the force or motion imparted by the two hands, and the twisting being in opposite directions, all the strands will be right, or all of them left-handed helices, in accordance with the twist given.

11. Let one half of these strands represent the force of the sun, and the other half the force of reaction absolutely developed by the motion of the earth. By continuing the twisting motion, and at the same time gradually pushing the bands more closely together the cords will project outwards on all sides equally, and exhibit a tendency to be arranged in a spheroidal manner.

12. To make application of this principle to the elevation of temperature and the expansion of bodies exposed on the surface of the earth to the full influence of the sun's force, we have to consider closely the direction in which the sun's force is applied; the direction of the force of reaction as described above; and the law which determines that temperature is raised in inverse proportion to the conducting power of the matter acted upon—a law which has special significance with reference to the heat generated in conductors of electrical currents. Having done this we are bound, as it appears to me, to recognise the fact that molecular motion and lateral extension of the helical lines of force must be in exact proportion, other things being equal, to the resistance matter offers to the passage of the two forces; for, in proportion as the force is impressed with a velocity which exceeds the conducting power of the mass, it is bound to display itself in driving the atoms asunder laterally.

13. We thus ascertain that the force which has been exerted upon matter to bind it together is simply diverted from its course; and that we really have to do with force and matter under three conditions or states, one of which is due to the action of the sun, another to the motion of the earth, and a third appears to be a natural concomitant of the gaseous, etherial, and expanded state of matter; or that condition in which matter is found when not subjected to the compressing influences of mass motion. This view is supported by our knowledge of the molecular condition of gases, which have a tendency to exist in the spheroidal state; and also of the vapourous state of water, as it exists in the form of steam, dew, or fog.

14. It further becomes a question whether this attenuated condition of matter is not also induced as a consequence of the molecules being subjected in a finely divided state to the influence of the two first-named forces in a degree which they—the molecules—have not capacity to retain, and which, consequently, displays its power upon them precisely in the same manner as it does upon the larger masses. And as the elevation of temperature, other things being equal, depends upon the density of the matter, we are naturally led to the conclusion that, in the finely-divided state in which matter exists in interplanetary space, there may be a very low temperature, owing to the same principle prevailing upon these infinitesimal particles as evokes low temperature at the poles of the earth.

15. Unquestionably, the more we investigate this universal principle of action, the more we realise that every condition of matter of which we can take cognisance is resolvable into the conversion of atoms into molecules, and molecules into masses, under the influence of forces acting upon helical lines from without; and, further, that by simply reversing the direction of the force it may be made to disperse masses and molecules, and reconvert them into atoms, the two processes being well illustrated by the iron filings under the influence of magnetic attraction and repulsion.

16. We further perceive in this expansion of one portion of the earth's surface, combined with the condensation of the opposite side and the condition of the poles, a third and not unimportant element in the earth's rotation; for balance of power or equilibrium must be affected thereby.

17. (Secondly). We have next to consider the operation of this force at the poles of the earth, and to realise the full extent of the influence we must bear in mind the fact that the force of the sun is constantly being impressed over the whole of the sunward surface of the earth; and that all this force, which may be expressed by hundreds of quadrillions of tons, has to be projected again as indestructible force at the magnetic poles.

18. We have also to remember that the force of the sun passes directly over the surface of the terrestrial poles, at which points it is gathered into vortices by the immediate influence of that portion of the sun's force which, having exerted power or done work upon the mass of the earth, is then emerging. We have, therefore, force from both these sources acting upon each other in oblique lines.

19. Again, we have to deal with the influence of the force due to the motion of the earth, which, as I have already shown, forms vortices in the opposite direction; the momenta of these vortices being due to the motion of the earth are equal to the force of the sun expended upon the earth, for the motion of the earth is due to the force of the sun.

20. These latter vortices move helically from west to east, owing to the constant change in the axis of the earth's inclination, whilst those due to the sun's action move from east to west, so that here again we have the principle evolved of one helical force moving into another, and thereby causing attraction in proportion to the helices operating, and we thus find in nature a grand demonstration of the mode in which the laws of motion are evolved, and that the principle accords in every particular with the theory I advanced as to the cause of artificial magnetic phenomena, *vide The Electrician*, June 25, 1881.

21. Confining attention at first to the sun's force which acts upon the mass of the earth from the line of the ecliptic to the poles, and to the force of reaction which is due to the motion of the earth, we perceive that each force is tending to press matter towards the centre of the earth, and, further, that the pressure from both these sources must be greatest at the poles of the earth, or at those points where, by the motion of the earth, the force of the sun acting in either direction has been brought to a focus.

22. Extending our observations outside the mass of the earth we find the sun's force displaying itself in lines which pass directly over each geographical pole for six months in the year alternately and persistently, and for twelve hours out of every twenty-four hours over each magnetic pole alternately. These lines of force are, therefore, moving in the same direction as the lines of force, also of solar origin, which, after having done work upon the mass of the earth,

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are emerging from the magnetic poles. Consequently, the laws governing oblique forces come into operation, and acceleration of motion and relief of pressure must be promoted thereby, and that in proportion to the degree and persistent character of the obliquity.

23. It is, therefore, evident that waves of motion must be communicated to interplanetary matter from these periods of magnetic acceleration, which occur as the opposite magnetic poles are exposed to, or removed from, the direct lines of the sun's force; and I would venture to suggest that the annual and diurnal variations of the magnetic needle, the equinoctial disturbances, and the motion of the mass in the form of an ellipse take their origin in these changes of motion.

24. The primary compressing effect of these influences of the sun is to increase density from the ecliptic in both directions towards the geographical poles, whilst from the flattening at the geographical poles pressure is suddenly relieved at those points. The secondary effect, due to the earth's motion, is to compress the earth from the poles to the centre.

25. This outline of the mode in which the force of the sun manifests its power upon the earth exactly accords with the expansion of bodies under heat as well as under cold, for we find that temperature diminishes as the rays of the sun become more oblique; and, taking the various conditions of water in illustration of the principle, we find that its density and temperature diminish in the same ratio until the temperature has been reduced to 40 degrees Fahrenheit, from which point down to 32 degrees Fahrenheit density appears to remain stationary. Sudden and violent expansion then takes place, and at the same time the liquid is converted into a solid.

26. We are, therefore, confirmed in the opinion already expressed, that the density of the mass of the earth depends upon pressure exerted from without, and that the sudden expansion of the liquid, water, whilst undergoing conversion into a solid, is absolutely due to that particular form of matter having acquired as a liquid its greatest capacity of holding force in its meshes at 32 degrees Fahrenheit, and that the force driven into it after its temperature has been reduced to 40 degrees Fahrenheit begins to operate in the opposite direction; whilst at 32 degrees Fahrenheit, under the influence of a sudden effort of an expulsive nature, the molecules are combined into a solid, the force manifesting the direction it has taken in the expulsive effort by the linear structure of the crystals, and especially giving proof of its continued presence in the solid by the change which is effected in the magnetic condition of the body, which from being a highly diamagnetic liquid has become a solid radiating magnetic force.

27. Professor Tyndall has experimentally shown that water becomes magnetic when it is converted into ice, and that the magnetic properties of ice vary at different temperatures. This is a very important fact, as evidencing the intimate relations which subsist between the material condition of a body and the power that body has of radiating magnetic force. Surely this single fact demonstrates—1st. That the same body, under different molecular conditions, gives out force with greater energy to the surrounding media, and in a direction which accords with the well-known lines of magnetic force, and, secondly, it is equally evident that a body cannot remain in the same physical condition and constantly impress force upon adjacent matter without obtaining its energy or capacity for doing work from some source external to itself. The thing would be a physical impossibility.

28. In the experimental researches of Professor Tyndall, referred to above, we have, indeed, proof given that the condensation of water has been effected by compression of its molecules by force which it has received from the surrounding media, and that when the capacity to retain force has been acquired it yields up the force in the same proportion as it has been received.

29. This principle may be illustrated by the manner in which bodies absorb water. Thus a piece of cloth will absorb and retain water in its meshes until saturation or its capacity for holding the water has taken place; then the stream of outflow will equal that of the influx, the cloth remaining saturated. The illustration may, indeed, be carried further by inclosing the cloth in a thin glass capsule, open at one side only to admit the water. By pressure from a pump we may then drive more water into the cloth, but a point will be attained when the glass envelope will be violently shattered owing to pressure from within. The cloth, however, will remain saturated, according to its capacity of holding the water, if the influx be maintained.

30. I am well aware that objection may be taken to the illustration, owing to the presence of the matter, but it is evident that were it not for the impressed force the matter under any circumstances would be quiescent. For instance, a number of billiard balls, as is well known, may be placed in a row, and a blow struck or force impressed upon one of the terminals will be transmitted through the row, but owing to stress the other terminal will be the only ball to move away, and if this were retained in its place, it would communicate its motion to the matter with which it came in contact. This principle is bound to hold good in every case of impressed force, the motion is always transmitted even if the matter with which it is associated be apparently motionless, or altogether from its tenuity invisible to our unaided senses.

31. From the statements already made, it will be perceived, first, that freedom of motion and molecular attritition are both increased, under the expansion of bodies, by force acting from within; secondly, that increased density, or condensation with reduction of temperature down to a certain point are the concomitants of pressure from without; and, thirdly, that below this temperature there is sudden expansion again owing to the capacity of matter for retaining force under great external pressure having been exceeded.

32. The principle here put forth entirely accords with the evolution of every natural phenomenon, for starting from the inter-tropical regions, we have abundant evidences of the dispersing force of the sun in the activity of molecular motion, which takes place in exact accordance, other things being equal, with the rectilinear direction in which the force of the sun is applied to the earth. This is especially marked in the propagation of light, in the evaporation of water, in the phenomena of animal and vegetable life—the radicle descending in the latter under the influence of the sun's force, or action, the plumule ascending under the force of the earth's motion, or reaction, and both formations frequently exhibiting the helical direction of the force operating. Cyclonic and other storms, the formation of dew, rain, hail, &c., are all of them evidences of the reverse principle, or the combining influence of the sun's power. Perhaps the phenomena of the water spout afford one of the most perfect methods of observing in nature the mode in which such vortices as I have described are formed under the influence of action and reaction, for in the upper inverted cone, in which helical motion is clearly discernible, sometimes of a double character, we have the matter aggregated which has been diffused in the atmosphere, and by its presence and motion imparting a like helical motion to the matter beneath; the two forces then mutually co-operate to unite the masses with which they are associated; and this having been effected, gravitation takes the matter to the earth in the manner I have described in my last letter.

32. Continuing our observations towards the poles we find molecular motion becoming gradually less marked, until at the poles, the vast fields of ice testify to the enormous force which is there operating to compress the liquid into the solid, with reduction of temperature from absence of molecular motion.

In my next letter I hope to define clearly the mode in which electrical phenomena are evolved under certain conditions of the same force.—Yours, &c.,

RICHARD C. SHETTLE, M.D.

Reading, June 23rd, 1882.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I wish Mr. Johnstone would keep to the point; too much time is lost in animadversions upon the ignorance of his opponents.

The question is, has Mr. J. proved that electricity is *matter?*

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I have not denied that it is, but what I say is, that he has most certainly proved nothing but the existence or the non-existence of currents under certain specified circumstances. What the interpretation of *current* is, Mr. J. has not demonstrated, so it still remains a "figure of speech," better comprehended by the theory of *energy*, or Faraday's "polarisation of atoms" than that of *matter*.

The parallelism about the voice consists in this, viz., that it no more follows that *matter* has passed through Mr. J.'s jar than that *matter* has passed through the window pane. Notwithstanding the relation of cause to effect, his allusions to vacuum, &c., are quite inappropriate.

Smeaton and Sir Wm. Watson were among the first to investigate the phenomena of the Leyden jar. The latter affixed to his jar knob, by a light jointed arm, a pith ball, which rose as the jar was charged (just as Mr. J.'s flame yielded), and he noted the fact that as the jar became charged the current gradually ceased. Yet Mr. Johnstone says *his* "discovery of the fact is new in the science of electricity." I am afraid he is mistaken.

Mr. J. recognises my admission of the term *current of electricity* as a "figure of speech," but objects to my application of the "figure" when alluding to the "neutralisation of a charge." Rather inconsistent, I imagine. The same conception of a decomposed *force* admits of its recomposition.

Mr. Johnstone forgets that his is the affirmative and mine the negative side of a proposition distinctly laid down by him, and, therefore, I decline to hypothecate to gratify him.

So far we are asked to believe that "because" a current ceases to flow from a fully-charged jar, that, "therefore," "electricity is matter."

"There is no such thing," says Mr. J., again, "as magnetic repulsion." Does he want to insult the intelligence of every schoolboy who points a magnet at his pocket compass?

Does Mr. J. want us to take his dictum for it, that *matter* actually passes hundreds of miles in a second *through matter* when a telegraphic message is sent from London to New York? What, again, are we to think of duplex telegraphy? If the electrical *matter* is infinitely attenuated, each despatch must wholly invest the conductor simultaneously. If not, then the *matter must have weight;* let Mr. Johnstone devote another experiment to ascertain it per volt.

"Induction is a myth," forsooth. What about an intensity coil? If the electrical current through the *primary* is "*matter*," the secondary has received it, according to Mr. J., beyond a shadow of doubt or the least attempt at logical distortion. But, lo! the secondary current is to the primary as Boreas to a Zephyr. Whence this increment? If so much *matter* did the business in the primary, where did the rest come from in the secondary? Echo answers, "Where?"

Dealing with *forces*, we can commend to our reasoning faculties such increments as are due to *gravitation* and the like; but not with *matter*. Mr. Johnstone objects to any parallels. Let me ask him what parallel there is between the distance from his dielectric to its insulator, and the distance from one side to the other of his dielectric itself? Let him join a telegraph wire in circuit with telephones, as I have done, and the induction sounds from its neighbour are audible; but increase their distance considerably, and the sounds are no longer heard.

Is it not incredible, again, that *matter* should prefer a solid body to air as its channel of motion? Yet a current takes a copper wire, rather than the free space around it.

Finally, the phenomena of the extra spark, the return current, are consistent with such ideas as reaction of *force*, but are irreconcilable with the conception of *matter*.

We recognise forces almost everywhere, but the ultimate atom of mere solidity nowhere, except in the imagination.

Let me conclude in the words, I believe, of the great producer of that "myth induction." "We must be careful to distinguish mere assumption from fact, nor yield to the temptation, so strongly fostered by habit, of referring observed phenomena to certain views to which the mind may have been long moulded and shaped" (say since 1839).—

Yours, &c., D. HARBORD.

Redhill, 1st July, 1882.

AMPERE'S MNEMONIC RULE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following suggestion of a mnemonic rule for fixing in memory the relation between the direction of a current and the deflection it produces on a magnetic needle has been sent me by Mr. G. F. Smythe, of Greylock Institute, South Williamstown, Mass., U.S.A. It is as ingenious as novel, and, if not of as universal application as the mannikin of Ampère, is at least worthy of preservation.—Yours, &c.,

SILVANUS P. THOMPSON.

University College, Bristol.

"As a substitute for Ampère's rule, given in your 'Elementary Lessons,' page 152, I have found the following useful, as being more easily retained, though not so scientific, perhaps. If the current flow from South to North Over the needle, the north-seeking pole turns West. S-N-O-W are the initials of the important words. So I say to my classes, 'Remember *Snow*.' Of course, if one is kept in mind, the other three cases are easily recalled."

LITERATURE.

MAGNETISM AND ELECTRICITY.*

This work seems to be the first of a series called the "High School Science Series." We have always had a strong partiality for Dr. Wormell's works, not because they are perfect but because they have been written both with a thorough grasp of the subject and a sound knowledge as to the best way in which the subject should be taught. This book is no exception to the rule, as will be seen from the extracts given further on, which we believe cannot fail to be understood by the average scholar if he gives only ordinary attention.

The book is divided into two parts—the first dealing with magnetism, the second with electricity. At the end of the first part, and interspersed in the second part, are pages devoted to questions on and descriptions of experiments in the laboratory, while at the end of the book, after the index, a number of examination papers are given. The various phenomena are illustrated by experiments described in the text. It is but just that we should call attention to the manner in which some of the diagrams have been cut or printed. Take, for example, Fig. 11, p. 27, which has six letters indicating six different points. Three letters are clearly given, one is broken, and two are unrecognisable. A French publisher would have burned the block in disgust, and justly. It is annoying to have to waste time to distinguish letters or parts of diagrams. On page 102, an *s* is referred to in the text, but it will not be found in the diagram; on page 132 we have *m* in the text, M in the diagram, *n* being correct in both, and so on. This is a minor blemish, but one that, with a very little care, could be avoided.

These mistakes point to careless revision, as also does 1·20 (p. 54) for 120, and no doubt will all be corrected in the next edition.

We have often spoken and written about the symbolic nomenclature adopted by electrical writers, and have urged that some general understanding should be come to in this matter. This is not the place to enter fully into the subject, but it may be worth while suggesting that the example of chemists might with advantage be studied. The most important phenomena may then be symbolised by the first letter, and others by the first as a capital followed by a prominent letter as a small letter, *e.g.*, C = Current, Cp = Capacity, and so on. It must not be supposed that because we do not discuss the paragraphs seriatim that we agree with all that is stated. We might question whether like poles do repel, whether "diamagnetism" is a correct term or

* *Magnetism and Electricity: An Elementary Text Book for Students.* By G. R. WORMELL, D.Sc., M.A. [Thomas Murby, 32, Bouverie-street.]

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not; but we recognise the necessity in a work of this kind of an author avoiding as much as possible controversial points and giving the student the generally-accepted views. That the reader may judge for himself of the author's method we give one or two extracts:—

MAGNETIZATION IS A MOLECULAR CHANGE.—The force by which the particles of a solid body are bound together is called cohesion. It is found, as might be expected, that the kind of iron which retains its magnetism best is that in which the force of cohesion is greatest. Moreover, whatever affects the cohesion of the particles in iron affects its magnetism. Heat lessens the cohesion and diminishes the magnetism of a steel magnet. Molecular attraction may be overcome, and magnetism destroyed, by sudden concussion. The twisting of a magnetised rod diminishes its magnetism. An iron or steel bar, which is slightly curved by its own weight, becomes straight on being magnetised.

When a bar is magnetised it stretches longitudinally and contracts axially. Hence there is greater density, so to speak, in the latter direction. This is manifested by the change that takes place in the thermal conductivity of the bar. If a thin plate of soft unmagnetised iron be covered with wax, and heated at its centre, the heat is conducted equally in all directions, so that the form of the melted wax is circular. If, however, the plate be placed between the poles of an electro-magnet, then the melted wax is ellipitical in form, being longer in the direction at right angles to the line joining the magnetic poles, so that the conductivity is greatest in this direction.

TANGENT GALVANOMETER AND VOLTAMETER COMPARED.—It follows that if a tangent galvanometer and a voltameter be included in the same circuit, the volume of hydrogen, at a constant pressure and temperature, produced in a given time will be proportional to the tangent of the deviation. For instance, the current produced by E M F of 1 volt through a resistance of 1 Ohm decomposes ·00146 grains of water in a second, and liberates ·0113 cubic inches of mixed gas per second, at temp. 32 deg. F. and under the normal pressure; hence the measure of a current decomposing x. grains of water a second is $x \div \cdot 00146$ volts; a current that liberates x. cubic inches of hydrogen per second is $x \div (\frac{2}{3}$ of $\cdot 0113)$ volts. It has been pointed out that the indications of different tangent galvanometers are not readily compared with one another. With a given current the deflection depends on the diameter of the rings and the force of the earth's magnetism, which varies in different localities. By comparison with the voltameter the indications of all such galvanometers may be reduced to a common standard.

It should be remarked, in connection with the electrolysis of water and other compounds, that the amount of chemical action in the voltameter is always equivalent to that in each cell of the battery; and if a number of voltameters be interposed in the circuit, the action in each will be chemically equivalent to that in the battery.

The chemical action that takes place in a cell containing copper, zinc, and acidulated water is as follows:—The water is decomposed, bubbles of hydrogen forming on the inner surface of the copper plate, and the oxygen combining with the zinc to form oxide of zinc. If we write Cu for copper, Zn for zinc, and H_2O for water, this action may be represented thus:—

$$\begin{array}{ll} \text{I.} & Cu \quad H_2O \; OH_2 \; OH_2 \quad Zn \\ \text{II.} & Cu \quad H_2O \; H_2O \; H_2O \quad Zn \\ \text{III.} & Cu + H_2 \quad OH_2 \; OH_2 \; OZn \\ \text{IV.} & Cu \quad H_2O \quad H_2O \quad Zn \end{array}$$

1. At first the molecules of water are supposed to rest in the vessel with the atoms of hydrogen pointing in different directions.

2. After the *poles* (as the zinc and copper plates are called) have been introduced into the liquid, the molecules of water become *polarized*, that is, they turn so that in each molecule the hydrogen is nearer to the copper plate, and the oxygen nearer to the zinc, as in the second row of the above formulæ.

3. When the circuit is completed, and the current flows, the hydrogen of the molecule of water nearest the copper plate is separated from the oxygen, and appears as bubbles on the plate. The oxygen of this molecule combines with the hydrogen of the next molecule, forming a molecule of water, and setting free another atom of oxygen. This combines with the hydrogen of the next molecule, and so on, until the atom of oxygen nearest the zinc plate is set free, and combines with the zinc to form oxide of zinc. The molecules of water are then left in the position represented by the third row of the figure.

4. As the current continues, the molecules again set themselves in the position described in II. and the process is repeated."

A feature in this little work is that the student is gradually led to see how the principles of the science have been applied in apparatus for electric light purposes, telegraphy, telephony, &c., while on p. 229 is the following paragraph devoted to Unsolved Questions.

UNSOLVED QUESTIONS.—Our knowledge of what electricity *will do* is still daily advancing, and we are justified in predicting that it will be of immense service in the future; but when we ask what electricity *is*, we have to confess that very little is known about it. In the case of sound or light, we know what it is that is transmitted, and also the velocity of the transmission and the direction it takes; but we have no similar knowledge with regard to electricity: we neither know what it is nor the process whereby it is transmitted. We have no certain clue to the actual direction of the transmission. We know how to produce electricity, or electrical action, and how to transmit it by means of wires to a distance; we know, also, that there is a dinymmetry at the two ends, or terminals, of a battery or machine, implying a directional character either in that which is transmitted or in the mode of its transmission, so that we cannot dismiss from our minds the notion of direction, and we have assumed it for convenience of speech and description. We have, however, no experimental facts that will decide whether the motion or "current" of electricity is to be considered as starting from one terminal and arriving at the other, or as starting from the second and arriving at the first; or, indeed, whether the motion may not be in some sense double, in both directions at once.

THE APPLICATION OF GAS TO THE LIGHTING OF OPEN SPACES.*

[Although the title of this paper mentions "Gas" only, it will be found that Electricity is a prominent feature in the body of the paper.—ED. *E.*]

BY WILLIAM T. SUGG.

It has very frequently been asserted by men of high position in the world of commerce, as well as by eminent scientific men, that the electric light is more suitable than gaslight for illuminating large areas. It is to be presumed that this *dictum* has been received as something absolutely true by a large section of the public. Chairmen of gas companies, in their half-yearly speeches, have even said pretty much the same thing, and have seemed almost to believe that really gas has no chance against the electric light, at least for large open spaces. In parenthesis let me say that it is also true that lately Professor Crookes and other learned authorities have told us that gas is neither so cheap nor so good as electricity for small spaces.

The House of Commons were moved by the statements everywhere made actually to order a trial of the most public-favoured specimen of the electric light for the purpose of lighting the Parliament Chamber, instead of gas, which was declared by some to be obsolete, impure, and deletereous to the atmosphere. The electric light, however, did not succeed, notwithstanding the permission given to the Brush Company, even to alter the ceiling by lowering a number of square glass lamps of considerable length down into the interior of the chamber. Gas was found to be superior to the Brush electric light for lighting the House of Commons, which is a large interior space. And here it is

* A Paper read at the late meeting of the Gas Institute.

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necessary to say that at no time, either before or after the experiment, could the heat or the products of combustion from the gas mix with the air supplied to the House; for two reasons—first, the pure air is supplied from below the floor, rising continually, and the vitiated air is carried off through the ceiling; secondly, because the gas-burners are fixed above the ceiling, which is of glass, and help to carry off heated air from the interior of the roof through their own ventilators, each one being separately ventilated.

Popular prejudice, however, does not reason; and there are still found men in high positions who repeat the same fallacies. Only lately the Commissioners of Sewers of the City of London invited tenders for lighting several of the streets of the City by electricity, and it was declared by one of their number (Mr. Innes) that the contracts they had before them showed that the electric lighting involved an expenditure of more than five or six times the amount then being paid for lighting by gas. The same body refused to pay three times the cost of the old lighting by gas for a new and superior system, which gives nearly six times more light than the old; and yet this new system of lighting streets by gas has often been declared by the public Press and by the general public to be superior to the electric light. Still more recently they have averred, as a reason for not adopting gas for the better lighting of the streets, that the Brush Electric Light Company were supplying their electric lights under contract for the same price as the Commission paid to the Gaslight and Coke Company for the 5ft. per hour lamps previously used. Yet it is a remarkable fact that the Siemens electric arc lights (which are produced certainly at as cheap a rate as any electric light now before the public) could not be supplied at a less cost than five or six times the price of the original gas lighting; and it is a still more remarkable fact that the Brush Electric Light Company did not offer to supply the whole of the City on the same terms as those under which they are now supplying Ludgate Hill and Cheapside, considering that it has been so frequently stated by their advocates that they can supply light for streets and open spaces at the same rate as gas.

It is true that it is now asserted that if they were allowed to light shops off the same wire as those supplying the public lamps they could do the electric lighting more cheaply; but they do not say how much more, neither does it appear that public and private lighting on the same wire could be managed with either safety or profit. But notwithstanding the figures of the tenders received and this positive commercial assurance that no one is willing to supply at a lower rate than five or six times the cost of gas, yet it does not seem to occur to the Commissioners that they might try gas for the purposes they require until electricity is proved to be able to do the work better and more cheaply. The reason why they do not try gas can, I believe, only be because they really think the electric light is superior to gas upon all points for this purpose.

From the first, since I saw the electric light in Paris, I have never had but one opinion on this subject, and that is, that whatever may be the proper use of the electric light—either of the arc form or incandescent form—neither of them is so suitable for lighting large space, either interior or exterior, as gas. I quite feel that, coming from me, this sounds very much like "There is nothing like leather;" but my opinion is founded on careful observations of electric lights in use, joined to a study of the system on which they are worked, and I think I can show a good foundation for my assertion of the superiority of gas.

First, as I stated in my letter to *The Times*, published October 11th, 1878, the electric light is deficient in volume. What I mean by this I will illustrate in the following manner:—It has long been customary—previously to the introduction of gas and even since—to light large spaces where such work as the unloading of barges on rivers, the loading and unloading of heavy goods, and general rough outdoor work is performed, by means of braziers, or, as they are generally called, "devils." These braziers are usually from 12in. to 15in. high, and about 10in. or 12in. broad, and when the coal or coke with which they are filled is in a state of low incandescence—viz., orange red—they diffuse a large volume of light, which covers a surprisingly wide space. The shadows of projecting objects on the ground are very slight, and for this reason this kind of illumination is often thought superior to other systems of lighting, more especially for work done on the water. I believe that one of these braziers, of large dimensions, used as a lighthouse light, is said by mariners to be more useful in very hazy weather than the most improved form of lighthouse lamp. I think, however, that this is not correct, because the volume of light, through extremely great, is of too low intensity to enable it to penetrate through even a slight mist so well as the light from a Wigham gas burner such as is used at the Howth Bailey light, off the coast of Ireland, or the improved lamp now in use by the Trinity Board, and invented by Mr. J. N. Douglass, their engineer. Professor Tyndall has declared the Howth Bailey gas light to be superior to the electric light for foggy weather. But the amount of light developed by an ordinary brazier such as I have described may be taken as generally not less than 600 to 1,000 candles, according to the degree of incandescence.

Now the very opposite to this light of low intensity and great volume is the electric light. The brazier has a radiant illuminating surface of about 500 square inches, one half of which is fully available in any direction. An electric light of 1,000 candle-power has only a total illuminating surface of about 12 square tenths of an inch, only 6 of which are fully available in any direction. The comparison of radiant illuminating surface is therefore as 50,000 : 6; so the brazier possesses more than 8,000 times more radiant illuminating surface than the electric light. This latter, is therefore, a light of high intensity, but of low volume. In the Dover lighthouses the electric lights are of about 7,000 candles measured in the photometer, and when placed in their admirably arranged Fresnel dioptric lanterns, the small but very intense point of light is developed out into a large surface of light of much lower intensity but greater volume, and they have a radiant illuminating surface of about 36 square feet. At 20 miles distance on a clear night the lights appear to be about the size of one's hand, or sometimes even larger than this. Now it is evident that if the lanterns were taken off, and the naked light only shown, at a comparatively short distance from the shore, the apparent size of the light would not be larger than a pin's head, although it would still possess in itself the full measured or nominal light of 7,000 candles. This light would, however, be useless to cover the space required, or to enable it to be distinctly seen by the naked eye at a very few miles from the shore. It is even probable that the light of a candle or at least a small lamp would, at a short distance, be more effective than this powerfully intense electric light. It is, therefore, clear that a light suitable for large spaces, or for lighthouses, must possess not only a certain intensity, but also a certain volume corresponding to its intensity.

To bring this point more closely home, I propose to instance the electric light in the City and on the Thames Embankment. It has been stated in the public journals that the Jablochkoff lights on the Thames Embankment are equal to 300 or more candles, and that the Brush electric lights in the City are equal to 2,000 candles. I am not disposed to say that they would not realise something like these figures if taken out of their lanterns at their best state of burning and placed at a suitable angle in a short photometer. But I have found that when they are tested in their places as they are used in these lanterns or globes on the tops of lamp-columns 11, 13, 15, or 16ft. high, they do not actually realise these illuminating powers.

The following details of experiments made on two very clear nights just lately will give an idea of the amount of effective light which really reaches the ground. The standard of light I have used for comparison is a Keates lamp, burning spermaceti oil, provided with a Methven slit placed across the flame of the burner, instead of vertically as in the Methven standard of light. The slit is of such size as to allow a portion of the whole light of the lamp equal to two candles to pass through it. This standard light, which I find is constant, is enclosed in a dark chamber properly ventilated; the front part of the chamber communicating by means of a

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square wooden tube with one side of the comparison disc. This disc is shaped like the letter A, and covered on both sides with white paper. On each side of the disc is pasted a cutting from a newspaper, one half the reading being on one side of the disc, and the other half on the other. The two sides are separated by means of a partition, which is carried up some distance above the discs. One side—that nearest the lamp—is covered so that no other light but that of the lamp can fall upon it; the other side is left open to receive the full light from the electric or other light to be examined. A mirror properly placed enables the observer to see both sides of the disc at once, and thus to judge of the relative amount of light falling on each. The standard degree of light I have adopted is, therefore, equal to that which will fall on a white surface from the rays of two candles placed at a distance of 3ft. from that surface. The photometer as thus used is on the Church and Mann principle, as you will perceive, but it is also arranged on the King principle, and may thus be used to measure the amount of light falling in any part of a roadway at a distance of 3ft. from the ground.

On the 5th of the present month, on a very fine, clear evening, I found that at 11:10 p.m. one of the Jablochkoff lamps (No. 4 on the list) on the Thames Embankment gave a light equal to two candles at 3ft. from the disc at a distance of 18ft. 8in. in a horizontal line. The height of the post above the level of the disc being 13ft., the angle of the ray was therefore 35½ degrees. This being so, a gas-lamp of the nominal power of 114·4 candles would, according to calculation, give a like result. As a matter of fact, however, a gas-lamp of the nominal power of 60 candles, consuming 25 cubic feet of gas per hour, which has, with a great many others of the same kind, been burning in the public streets for many months past, gave on the 9th of this month (measured by the same standard) a light equal to 125·3 candles. The distance from the post was 22ft. in a horizontal line, and the light was 9ft. above the disc of the photometer; the angle of the ray was therefore 23 degrees.

It is necessary to mention here, in order that you may understand clearly the bearing of the observation as to angles, that in a published report which I have before me, dated May 24, 1882, Professor Ayrton and Mr. John Perry say that "with all electric lights the intensity of the illumination is different for different angles in the same vertical plane," and as the summary of the results of their observations at different angles of inclination they give the following:—

Horizontal	1129	Candles per horse-power electrically given to the lamp.
17 degrees	2637	
34 degrees	3042	

The electric light, therefore, in this instance appears to have the least angle. I think you will perceive from these facts that, if the cost of the electric light is a slippery subject to get hold of, the estimation of their illuminating power is enough to puzzle the most experienced photometrists.

At the refuge near De Keyser's Hotel at Blackfriars, I found on the same night that the Brush electric light there produced the standard light of 2 candles on the disc at a distance of 47ft. 6in. from the post in a horizontal line. The height of the post was 17ft. above the photometer disc; the angle of ray was, therefore, 20 degrees. Consequently, according to calculation, a gas burner of the nominal candle power of 557 candles would have produced the same result. As a matter of fact, on the 9th of this month, at 10:35 p.m., a gas lamp which has been burning in the public streets for many months gave (measured by the same instrument) a light equal to 501·4 candles, with a consumption of 90 cubic feet of gas per hour, at a distance of 44ft. 11in. from the post in a horizontal line. The height of the lamp above the disc was 15ft. 4in.; the angle of the ray was 19 degrees. In this instance the Brush light had slightly the best angle.

In both cases the gas lamp gave a constant light, and the electric light did not. The gas lamp gave its light the same in all directions round the post. The electric lamp in the latter case did not appear to do so, the results being—Down Bride-lane, 582 candles; on pavement towards bridge, at right angles with Bride-lane, 320·8 candles; across road in direct line with Bride-lane, 267·4 candles—total, 1170·2 candles. Average of the three observations, 390·2 candles.

Nearly in front of *The Times* office, in Queen Victoria-street, is a lamp on the Lontin system, which produced the standard light on the disc, at a distance of 80ft. 6in. from the post on a horizontal line. This is the most powerful light I have yet tested. To produce the same amount of light by gas would require a lamp of 1466 candle-power. Calculating from the results given in respect of the gas lamp before mentioned, a similar lamp of larger dimensions, and consuming about 280 cubic feet of gas per hour, would equal this light.

Those of you who have seen the electric lamps and some of the larger gas-lamps in use in all parts of the country, the nominal illuminating power of which does not exceed 300 or 400 candles, must have remarked that these nominally much more powerful electric lights do not light the ground better than those gas lamps of smaller nominal value. It is a remarkable fact that although at the Electrical Exhibition at the Crystal Palace the electric lights in that part of the Nave where the Kings' and Queens' screen is, numbered many thousands of candles, it was not possible from the Centre Transept to tell the time by the large clock at the south end of the Palace, which is a great deal more than 20ft. in diameter and figures about 6ft. in length. Yet I need not tell you that if that part of the Palace had been lighted by gas to a tithe of the nominal number of candles which the electric light was said to represent, it would have been a very easy matter to have read the time on a much smaller dial.

You will naturally expect that I should be able to give some reason for this curious fact. This reason is another of my arguments why the electric light is not as suitable as gas for lighting large spaces. The electric light is composed largely of highly refrangible rays which move at a very high rate of velocity. To illustrate this, let us refer for a moment to the brazier. There we have a great number of heat-rays which are the least refrangible, and which are generally supposed to be invisible to our organs of vision because of the comparatively low rate of speed at which they move. But this heat-ray, as pointed out by Professor Tyndall, is an enormous mountain amongst the other rays of the solar spectrum; and between this heat-ray and that part of the solar spectrum approaching to yellow there are a number of dark red, red, bright red, and orange rays, of low refrangibility and slow movement, which are useful to us when they are not interfered with by the more rapidly moving and more highly refrangible rays which irritate the optic nerve most violently, and render it as it were insensitive to the rays of low intensity. Captain Abney, of South Kensington, who has done more than, perhaps, any man living to elucidate the theory of photography, has shown us that even this red ray can be photographed, and thus that it probably must have a sensible effect on the human eye, more useful for the purposes of vision than has been before supposed. Now the electric light, in comparison with the brazier, possesses few heat rays, but it has an enormous quantity of rays which belong to the other end of the solar spectrum, notably the other invisible ray which is the antithesis of the heat ray—I mean the actinic or chemical ray. Professor Tyndall tells us that to produce the extreme violet rays the retina of the eye is struck 789 millions of times in a single second, and that at this point the retina ceases to be useful as an organ of vision. This ray is, however, the most useful to photographers, but does not appear at all useful in artificial lighting. On the contrary, nature provides us in summer evenings with a light which is good and strong enough for working indoors as well as out, and which, after the glare of full day, is most acceptable to the sight. This light is pure and very slightly yellow or rosy from the last beams of the setting sun, but is almost devoid of the actinic or violet rays, although it possesses the pale green ray and all the others from that towards the red. Therefore it is grateful to the sight, and is powerful to illuminate us; in fact, it possesses volume and sufficient intensity without the violently refrangible and high-velocity rays which require the strong golden beams of the sun to connect and tone down their effect, and prevent them from being in-

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jurious to the human eye. This evening light is, in my opinion, what we require to replace the light of day after the sun has set. But this we most decidedly do not get from electricity in the arc form, as it is now used for lighting large interior or exterior spaces. But we can obtain such a light from gas, as I shall be able to show a little further on. Lastly, the highly refrangible rays are scattered and diverted from their course by molecules of water, and do not reach the point to which it is the intention they should be directed, even in the ordinary moist state of the atmosphere on a fine evening.

Here it is necessary to mention another fact for which we are indebted to the scientific research of Professor Tyndall—viz., that a ray of light is absolutely invisible unless it strikes upon something which may reflect it. Now, bearing this fact in mind, and remembering also that the heat and red rays, in passing through a globe of water, go nearly straight through, all the others—the orange, yellow, green, blue, and violet—being more and more bent out of their course in the order in which I have mentioned them, till in this last visible ray, and still more in the actinic ray, they reach their highest degree of refrangibility, it is clear that a light which is largely composed of these rays cannot be so serviceable for artificially illuminating a space, whether interior or exterior, as one which possesses the most rays of a lower refrangibility combined with a sufficient volume of those rays which give intensity to the light. This is the combination which we have readily available in gaslight.

It has been and will be argued that gas can never represent that mellow evening light which I have spoken of. On this point I have to cite a most interesting experiment which has only been tried within the last few days. I have spoken of the lighting of the House of Commons, and mentioned the failure to give equal satisfaction to that experienced with gas lighting which resulted from the trial of the electric light proposed to be employed instead of gas. From what I have stated as to the peculiarities of the arc electric light, you will, I think, be able to see why it could not be so successful as gas.

It has been urged that the colour of the gas light is not like that of day; it is yellow and smoky. In the House of Commons it is not easy to show whether it is or is not like the daylight, because the gaslight does not come from the same point as the daylight, and therefore the change of position tells us when gas is lighting the House. But in the new Reading Town Hall, which was opened on the 31st of May last, the architect has arranged a glass cove round the hall under the ceiling line. The daylight enters the hall first through skylights on the external roof, and then descends through the glass cove. Behind the glass cove, at a short distance from it, are placed the gaslights, each of 100 candle-power, and each provided with a ventilating shaft to carry off the products of combustion. Thus the daylight and the gaslight enter the hall from the same points; the consequence being that the following experiment as to the relative colour of gaslight by daylight could be, and was tried on the opening day:—A grand concert commenced in the hall at half-past seven, or at the time when the area was well lighted by the evening light I have spoken of, so that any small print could easily be read in any part. The last beams of the setting sun fell on the skylights of the roof, producing a fine mellow, soft, white light. The gas was then turned on to its full power, 9,000 candles for the entire hall (62ft. 6in. by 98ft. 0in.). No perceptible difference could be perceived in the light from that time till the concert came to an end at nearly eleven o'clock. The daylight gradually went, and the gaslight imperceptibly took its place; and it was remarked by every one that the change from daylight to gaslight had not been remarked. One of the public journals of Reading mentions this fact. So much did the gaslight resemble daylight that some of the audience found that it was dark when they came out of the hall between the parts, having imagined they had been sitting in daylight all the time. It is remarkable that when the daylight was lighting the hall and the gaslights were turned full on, they did not appear to alter the colour or the illuminating power in any way. But as the daylight disappeared they took up the lighting. Like the House of Commons, this hall cannot be in the least affected by the heat or products of combustion from the burning gas.

This, then, I say fulfils all the conditions of artificial lighting as to colour of light, softness of light, and volume, with perfect steadiness and control, and absence of highly refrangible and chemical rays, and with no products of combustion to vitiate or heat the atmosphere. Is not this, I ask, a suitable light for any of those museums or libraries of which we have heard so much? And does any system of electric light fulfil any of these conditions so well as gas?

As to open spaces, when the products can escape into the air, the conditions of lighting, however difficult to fulfil by electric system, are easily and silently done by gas without the least fuss or uncertainty of any kind, and with an entire absence of supervision at any of the points of illumination. More than this, gas is steady; and I only wish any one who says anything about the steadiness of the electric light to try it in the public streets, *in situ*, as I have done. He will soon find that the difficulty experienced by the Irishman in counting one of his little pigs is one of the things still to be got over by the electricians before gas can be abolished.

I think I need not in this paper, which is sufficiently long already, mention anything with regard to the lighting of large spaces by incandescent lamps. Although the colour of the light is more nearly approaching to the proper conditions of useful artificial light, yet it is abundantly clear from the number of lamps always required to light even a very small space, that they do not possess volume. Independently of this, their extreme delicacy will probably preclude their employment in places where delicate fingers are not constantly available for their careful manipulation. These cannot for open spaces, such as squares, railway stations, docks, &c., pretend to any serious rivalry with gas, either in point of usefulness, steadiness, readiness, or cheapness.

As regards the lighting of large interior spaces, such as workshops, in which there are particular dangers from fire to be guarded against, it has been stated and believed by the public that gas cannot so well be employed as electricity. Let me instance the large new workshops of Messrs. Mowlem, Burt, and Freeman, in Westminster, which, after serious consideration on the part of the principals, and visits to electric lighting exhibitions, was finally lighted by gas, after a clearly demonstrative experiment that gas was cheaper, readier, better, and safer than any electric light.

I am authorised by Messrs. Mowlem, Burt, and Freeman, who are thoroughly satisfied with the lighting, to say this. The gaslights, each of which equals 100 candles, are enclosed in lanterns, which are locked, and are lighted by flash jets left burning inside without opening the lamps. Therefore, although there are small shavings constantly flying about from the machinery, none of them come into contact with the lights. The experience of incandescent electric lamps and others does not show them to be any safer than gas.

It is the case that from time to time gentlemen having a very little acquaintance with gas and less with electricity rush into the columns of *The Times* and other journals and give particulars of the cost of electric lighting in comparison with gas. With that delightful archness which arises from their ignorance, they usually omit from these calculations the not unimportant items of rent, rates, and taxes, and the most important item of all—profit. Perhaps under the circumstances they ought to be pardoned this latter omission, as it is generally believed that it has not yet appeared in electric lighting accounts, excepting in the way of speculation.

But I feel that it is needless to weary you and myself with any attempt to demonstrate the relative cost of electricity and gas till some scientific conclusion is arrived at as to what is an electrical horse-power. How is a horse-power to be electrically given to a lamp? What is an electrical candle? What is the proper angle at which electric lights are to be examined; and, consequently, what is the corresponding angle for the gaslight to be tested in comparison with any electric light? Lastly, is the principle that light decreases as the organs of the distances to rule the construction of electric photometers as it does those used for gas? Sufficient for me in this paper, to feel that I have proved that gas is steadier and readier, and more useful for the purpose

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of lighting large interior and exterior spaces than electricity. *The Times*, in its issue of the 3rd ult., has a leader on the prospects of electricity, and after mentioning that, according to Professor Crookes, the incandescent electric lights will be cheaper than gas, when certain charges incidental to the mode in which he obtains his power have been disposed of, says:—

"It must be remembered, however, both in regard to this and to street lighting, that any comparison now made, in respect either of cost or of illumination, is made with gas very imperfectly applied. Gas when first introduced presented so many advantages over the lights which had preceded it that it afforded an amount of satisfaction in excess of its actual merits, and it is still being consumed in many places on a plan which in the present day may almost be called barbarous. Within the last few years greatly improved burners have been introduced, and the attention of gas engineers has been keenly directed to the subject by the competition of electricity. There are many streets in London which show how much ordinary gas lighting might be improved, and there can be little doubt that the improvements now to be seen are but the precursors of others. It would, therefore, be premature to suppose that the claims of electricity will have to be weighed only against those of gas as now commonly employed, and not against gas employed under more advantageous conditions."

Professor Crookes is a customer of the Gaslight and Coke Company, to the extent of about 500ft. of gas per night for two rooms, which were never before lighted by gas; so that if many of the rich go and do likewise the sale of gas is likely to be increased very considerably for lighting houses and rooms to which it was before a stranger. Messrs. Samuel Brothers, of Ludgate-hill, the well-known tailors, light their show rooms by the Jablochkoff light, which is the nearest electric light approaching to the conditions of a gas burner or candle. They have 20 lights, and employ a gas engine which costs 2s. per hour for gas, and develops 23 horse-power by indication whilst the lights are on. The illuminating power of each lamp is not known at present. Gas is an incandescent light of very large volume as compared to the almost invisible filaments from which the electric light is radiated. The comparison between the two is almost as great as that between the brazier and the electric lamp.

As *The Times* remarks, improvements are continually going on; and I can assure you, from my personal knowledge, that there is a very sharp competition in gas, independently of the outside competition of the electric light. The result of this must and will be improvements in the use of gas and of all kinds of apparatus employed with it. Those inconveniences which generally attend its use now—such as heat and products of combustion—will disappear rapidly; and in saying this I feel I have a much more solid foundation for the expression of my hope than those enthusiasts who make use of the glib assertion, "Oh, they will get over that," to cover all those defects which have been the faithful and never-absent companions of the electric light ever since it made its present appearance four years ago.

The electric light is a scientific light, and so is gaslight; and with all improvements which are capable of being made in both, electricity will find it very hard, when the novelty has worn off, to take a permanent place by the side of gas. It cannot replace it.

THE TELEPHONE FOR COLLIERIES.—A telephone line has been erected between Lord Lonsdale's colliery office in Duke-street, Whitehaven, and the Henry pit, and it is stated that if it works successfully the other pits will be connected in a similar manner. The line has been put up by Mr. Watson Bell. We scarcely think that Whitehaven is likely to prove an exception to the general rule, and, consequently, we shall expect to see telephones multiply in that locality, since there is no doubt as to their extreme utility. We believe that up to the present the mode of communication between the head office at Whitehaven and the various pits has been by special messengers. The advantage of telephones over special messengers need hardly be pointed out.

SUBMARINE CABLES.

The following letter has been received by Mr. John Pender, M.P., from the Board of Trade, under date 1st July:—

"SIR: With reference to former correspondence, and especially to your letter of the 24th of April last, in which you transmit prints of clauses which the telegraph companies represented by you wish to see made law, with a view of protecting submarine telegraph cables from injury, and of preventing impediments to the operations of cable-repairing ships, I am now to offer the following observations:—The Board of Trade have been informed by several other telegraph companies that the utmost measure of protection which they desire is to be protected from 'wilful and wanton or careless injury.' The wishes of these companies seem to be practically satisfied by English law as it at present stands. It appears to have been determined, both at Common Law and in the Admiralty Court, that a vessel whether English or foreign is bound in dealing with the telegraph cable to exercise ordinary skill and care, and that, if either within British limits or beyond them, a vessel does injury to a telegraph cable, which, by the exercise of ordinary skill and care she might have avoided doing, she is liable in damages to the owners of the cable. These points appear to have been decided in 'The Submarine Telegraph Company *v.* Dixon' (1864), C. B., *Law Times*, Vol. X., page 32; and 'The Clara Killam' (1870), *Law Reports* 3, Admiralty and Ecclesiastical, page 161.

"It appears also that any malicious injury to a telegraph cable committed within British jurisdiction, or committed elsewhere by a British subject or a British vessel, can be punished criminally in the courts of this country, under the Malicious Injuries Act, 24 and 25 Vict., Cap 97, Sections 32, 51, 52 and 72, and under the Merchant Shipping Act, 1854, Section 267. If the law of foreign nations corresponds in these several respects with the law of Great Britain, it would seem that all the remedies which are needed in order to satisfy the more moderate demands of the telegraph companies already exist under British law, and it would, therefore, remain to ascertain what is the state of the law of foreign countries on these points. The civil remedy, it is to be observed, is by the law of England applicable, whatever be the nationality of the ship, and wherever the place where the injury is inflicted. The criminal remedy for an offence committed beyond British limits is not applicable in the courts of this country to a foreign ship, and could not be made so applicable without the consent of foreign nations, and they would not be likely to consent to this being done.

"The wishes of the companies represented by you, as embodied in the clauses which accompanied your letter under reply, appear to comprise the following additional proposals:—(*a*.) 'That the Board of Trade shall publish charts with all the telegraphic cables marked on them, and that vessels shall not anchor within one mile of any cable so marked, except in case of stress of weather or other sufficient cause, and shall as far as possible avoid dragging with anchors or trawls near such cables.' To the proposed publication of such charts and the obligations to respect the positions marked in them, there is more than one objection. In the first place, it may not be desirable to give to all the world official notice of the exact position of telegraph cables, but independently of this it appears to the Board of Trade that it is neither just nor practicable to impose such a limitation as is here suggested upon freedom of navigation. The multiplicity of cables is already so great that spaces a mile wide on both sides of each cable would in the aggregate amount to a large fraction of the ocean bed in some seas, and the reservation of such spaces would, therefore, seriously limit the operations of fishing and navigation, and this is without taking into account the possibility of an indefinite increase of the number of cables as time goes on. It must be remembered that cables have only been laid in recent years, whilst fishermen and other seafaring persons have pursued their calling from time immemorial, and if either side is to give way it is not easy to see why it should be the earlier occupiers of the ground who are to be made to yield.

"Further, the difficulties in the way of enforcing such a rule as that proposed against all merchant ships and fishing vessels would be very great, and would involve the necessity of maintaining a fleet of ocean police vessels, in order to prevent the rule becoming a dead letter, whilst on the other hand the irritation which would be produced among fishermen and others, and the disputes likely to result therefrom must also be taken into account. The clauses you suggest go on to provide—(*b*) 'That it shall not be lawful to approach a ship engaged in laying a cable so as to obstruct her operations.' (*c*) 'That if a cable is fouled by an anchor or trawl the persons so fouling it shall take care to do as little injury as possible.' (*d*) 'That persons navigating or fishing near cables shall use the utmost care not to foul or injure them, and if they foul them to do as little injury as possible.'

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These three proposals seem to be already provided for by the existing English law, as far as is wise or practicable, and the alteration of the international regulations for preventing collisions at sea in respect to the signals to be displayed by cable laying or cable repairing ships which you are aware is in contemplation, will add force to this law. Your clauses then proceed as follows :—(*e*) 'Wilful or negligent cutting or destruction of a cable or removal of a 'telegraph ship or gear to be a subject for damages.' This also seems only to express the existing English law. The next clause provides that—(*f*) 'Any wilful or negligent contravention of the proposed rules is to be also criminally punishable by a penalty not exceeding £50."

"This would be intolerable if applied to the case of a ship merely approaching a cable or a cable-laying vessel, whilst it has yet to be shown that the punishment of offences against the property of a telegraph company is not sufficiently provided for by the Malicious Injuries Act. Finally, it is proposed that:—'(*g*) Officers of Customs shall have power to prevent the use of dangerous trawls.' This is, to say the least, a provision of an extremely doubtful character, and one which it would be scarcely possible to enforce. It has, furthermore, to be remembered that it is much to the interest both of fishing vessels and other ships not to foul telegraph cables; and that, as has been stated by some of the companies, proper care is secured more effectually by establishing and maintaining friendly relations with the fishermen than by the enactment of penal provisions against them.

"Under these circumstances the Board of Trade, as at present advised, would pause before recommending the adoption of the clauses which you have sent to them. But I am to add that Her Majesty's Government are still in communication with foreign governments on the subject.—Yours, &c.,

(Signed) "T. H. FARRER."

THE EASTERN TELEGRAPH COMPANY (LIMITED).

Report of the directors to be presented to the twentieth half-yearly ordinary general meeting and to the extraordinary general meeting, to be held July 13th. The directors submit the accounts and balance-sheet for the six months ended 31st March, 1882. The Company's revenue for this period amounted to £321,810 13s. 5d., from which are deducted £75,140 19s. 5d. for the ordinary expenses and £40,269 13s. 2d. for expenditure relating to repairs of cables during the half year. After providing £2,585 1s. 4d. for income-tax, there remains a balance of £203,814 19s. 6d., to which is added £29,504 9s. 6d. brought from the preceding half year, making a total of £233,319 9s. From this amount there is deducted £22,726 9s. 2d. for interest on debentures, £20,559 1s. 3d. for dividend to 31st March, 1882, on the Preference shares, and £75,000 placed to the general reserve fund, leaving a balance of £115,033 18s. 7d. The directors have during the half year paid an interim dividend of 1¼ per cent. on the Ordinary shares for the quarter ending December, 1881. They now recommend the declaration of a final dividend for the year ended 31st March, 1882, of 2s. 6d. per share, and a bonus of 1s per share, both payable on the 14th inst., making, with the three previous payments on account, a total distribution for the year of 5½ per cent. on the Ordinary shares. The balance of £1,033 18s. 7d. shown at the foot of the revenue account is proposed to be carried forward to the next half year. The general reserve fund, after adding the interest received during the half year, now amounts to £443,535 1s. 7d.; this, with the special reserves stated on the balance-sheet, makes the total amount of reserves £490,816 14s. 6d. The revenue includes £19,500 received for the half year upon the Company's shares in the Eastern and South African Telegraph Company. The reserve funds of that company now amount to £118,695 0s. 11d., and in additon the sum of £37,537 10s. is held by the trustees of the sinking fund for redemption of debentures. The revenue account also includes £2,600 dividend for the half year on the shares of the Black Sea Telegraph Company, belonging to this Company, by which the line is worked and maintained under agreement. The various sections of the Company's cables are in good working order with the exception of the Direct Lisbon line and the 1870 Aden-Bombay cable. The Lisbon end of the direct cable has been recovered and buoyed, but the operations of the Company's ships on the northern end of the line have been delayed owing to the continuance of very rough weather. The repairs to the Aden-Bombay cable have been deferred during the prevalence of the South West monsoon. Owing to the disturbed state of affairs in Egypt, the directors, acting in accord with H.M. Government, have made arrangements to secure telegraphic communication with the fleet at Alexandria in case the connection with the shore should be interrupted. The ss. "Chiltern" has been brought from her station in the Red Sea to Alexandria, and is now there in readiness for further requirements. A concession has been granted by the Emperor of Austria for the laying of a submarine telegraph cable between Trieste and Corfu. The cable has recently been laid by the Telegraph Construction and Maintenance Company, thus placing Austria, Hungary, and the central part of Europe in direct submarine telegraphic communication with this Company's cables in the Mediterranean and Levant. The concession is exclusive for twenty years, and entitles the holders preferentially to the transmission of all official messages and to all private messages not specially directed to be sent by another route. As stated at the last ordinary general meeting, the board have made arrangements for taking over the line and concession, and a resolution will be submitted to the extraordinary meeting empowering the directors to do so at a price not exceeding £67,000. The directors have concluded an arrangement with the Turkish Government for the re-establishment of the connection by telegraph cable between Malta and the Regency of Tripoli, a distance of 220 miles. The cost will be about £25,000. A resolution will be submitted to the extraordinary meeting approving the arrangement. At the extraordinary meeting special resolutions will be submitted authorising the creation and issue of mortgage debenture stock of the Company. It is proposed to create a 4 per cent. stock charged upon the undertaking and revenue of the Company for a total sum not exceeding one-third of the amount of paid-up share capital of the Company for the time being. This is the proportion usually sanctioned by Parliament for mortgages of other industrial undertakings. The new stock is intended to be issued from time to time for conversion or redemption of all the outstanding debentures of the Company, now amounting to £882,000; to provide for the acquisition of the Trieste-Corfu cable and concession, the laying of the Malta-Tripoli cable, and other important expenditures on capital account as and when required. Power will be taken for the Company out of the reserve funds, or moneys voted by the shareholders, to purchase in the market and hold or to cancel and afterwards re-issue, such portions of debenture stock as may be found expedient. The directors believe that by the conversion of the existing terminable debentures, now bearing interest at 5 and 6 per cent., into an uniform Four per Cent. Stock secured as a first charge upon the revenue of the Company, a very substantial saving will be effected, and the finances of the Company placed in a permanently improved position.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices July 5.		Business Done Week Ending July 5. Highest.	Lowest
Anglo-American	52,	53	52⅝	51¾
Do. Preferred	83,	84	83⅜	82
Do. Deferred	22½,	23⅛	22⅞	22¾
Brazil Submarine	11⅝,	11⅝	11⅝	11¼
Cuba	9¾,	10¼	9⅞	9⅞
Do. Preference	16,	17	—	—
Direct Spanish	6¼,	6¾	—	—
Do. Preference	15½,	16½	—	—
Direct United States Cable	11⅞,	12⅛	12	11¾
Eastern Telegraph	10,	10¼	10⅜	9 15-16
Do. 6 per Cent. Preference	13,	13½	13⅛	13⅛
Do. 5 per Cent. Debentures, 1899	102,	107	—	—
Eastern Extension	11,	11¼	11 5-16	11⅛
German Union	9¾,	10¼	—	—
Globe Telegraph and Trust Company.	6¼,	6½	6¼	6¼
Do. Preference	12⅛,	12⅝	12 5-16	12 5-16
Great Northern	12½,	13	—	—
Indo-European	28,	29	—	—
Mediterranean Extension	2,	2¼	—	—
Do. Preference	8½,	9	—	—
Reuter's	12¾,	13¼	13¼	13¼
Submarine	265,	275	—	—
West India and Panama	1½,	1¾	1 11-16	1 11-16
Do. 1st Preference	8,	8½	8¼	8¼
Western Brazilian	7,	7½	6⅞	6⅞
West. Union 7 per Cent. 1st Mortgage	121,	126	—	—
Do. 6 per Cent. Sterling Bonds	102,	105	105	105

TELEPHONES.

Consol. Telephone and Maintenance	1⅝,	1⅝	1⅝	1 7-16
Oriental	⅜,	⅝	9-16	9-16
United Telephone	13,	13½	13½	13

ELECTRIC LIGHT.

Electric Light and Power	¾,	1	⅞	13-16
Anglo-American Brush	25½,	26½	27½	25⅞
Eastern Electric	4,	4½	4¼	4

TRAFFIC RECEIPTS FOR JUNE, 1882.

Companies.	June, 1882.	June, 1881.	Incrse.	Decres.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,900	2,837	63	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	31,122	29,339	1,783	—
Eastern Telegraph Company	46,450	40,074	6,376	—
Great Northern Telegraph Company	22,560	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

GRIFFITH & CO.
(LATE HARBOROW & CO.,)
ELECTRIC LIGHT ENGINEERS
AND
TELEGRAPH INSTRUMENT MANUFACTURERS
4, QUEEN ANNE'S GATE S.W.

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

2482. ELECTRIC MACHINES, *E. G. Brewer.*—*7th June*, 1881.—(*A communication from T. A. Edison, New Jersey, U.S.*) 8*d*.

This relates to the interposition of resistances in the field magnet coils, or in the main circuit, and otherwise regulating and controlling the generation of the current.

3190. FITTINGS FOR ELECTRIC LAMPS, *R. R. Hughes, London.*—*21st July*, 1881. 6*d*.

This invention relates to a number of minor arrangements in order that ordinary gas-fittings may be utilised for electric lamps.

3211. AN IMPROVED PROCESS FOR OBTAINING ZINC FROM ITS ORE AND FROM OTHER MATERIALS, *H. H. Lake, London.*—*22nd July*, 1881.—(*A communication from L. Létrange, Paris.*) 8*d*.

This consists in the application of dynamo-electric or magneto-electric currents to the decomposition of the zinc ore. In the case of *blende*, the ore is roasted at a moderate temperature so as to decompose the sulphates without allowing the sulphur to escape more than is absolutely necessary; the sulphate of zinc thus produced is then dissolved in water and subjected to the action of the electric current, which precipitates the zinc in a metallic state and renders the acid derived from the decomposed salts available for use. When calamine or oxides of zinc are to be treated a sufficient quantity of *blende* is introduced to furnish the sulphuric acid required to form a permanent bath of sulphate of zinc.

3294. AN ELECTRICAL MUSICAL INSTRUMENT, *W. F. Schmoële and A. Mols, Antwerp, Belgium.*—*27th July*, 1881. 8*d*.

This invention is a combination of pneumatic and electro-magnetic apparatus to be applied to a piano, so that the piano may either be played by the keyboard of the apparatus, or the latter may be played as a reed instrument alone, or the music of the piano may be combined with that of the reed instrument. The pneumatic portion of the apparatus provides the motive power, the electro-magnetic portion times and regulates its application. The passage of the current is regulated by a sheet of perforated paper which constitutes the music, and which is drawn forward by rollers at a regulated speed. A series of metallic fingers underlies a metal cylinder connected with a battery, and the perforated paper is made to pass between them. When a finger coincides with a perforation contact takes place, and the current flows to a series of electro-magnets, which instantly raise the pneumatic levers to operate a series of strikers, whereby the keys of the piano are actuated. Means for effecting a gradation of tone, for accentuating particular notes, &c., are also described. The specification is accompanied by detailed drawings of the apparatus.

3305. IMPROVEMENTS IN APPARATUS FOR DISPLAYING AND REGULATING ELECTRIC LIGHT, *Sir C. T. Bright, London.*—*28th July*, 1881.—(*Not proceeded with.*) 2*d*.

The invention consists in regulating the feed of the carbons by the action of two bar electro-magnets, together with a rack and train of wheels.

3435. AN IMPROVEMENT IN ELECTRIC LAMPS OPERATING BY INCANDESCENCE, *F. Wright, London, 8th August*, 1881.—(*Not proceeded with.*) 2*d*.

This relates to a method of clamping the carbons and conductors by means of a block of carbon, without the use of cement.

3437. INCANDESCENT ELECTRIC LAMPS, *F. Wright, London.*—*8th August*, 1881.—(*Not proceeded with.*) 2*d*.

The fibre selected for the incandescent material was that used in making "bass" brooms. The fibre was carbonised and treated in hydrocarbon vapour.

3441. IMPROVEMENTS IN AND APPERTAINING TO APPARATUS FOR GENERATING ELECTRICITY AND MEANS FOR UTILISING THE SAME IN PRODUCING THE ELECTRIC LIGHT, *R. R. Moffatt and S. Chichester, Brooklyn, New York.*—*9th August*, 1881. 8*d*.

This invention relates to an improved dynamo machine and arc lamp. The improvements in the machine consist in an armature having its greatest length of cross section parallel with its axis, and being mounted on a central carrier, with the poles of the exciting magnet so arranged that they will envelop a larger portion of both inner and outer surfaces of the armature cylinder than is usual, thus reducing the amount of resistance to a minimum. Also to the application of iron lugs upon both inner and outer surfaces of the core, so as to cause the latter to be more highly charged owing to its closer metallic proximity. The improvements in the construction of an elecric lamp consist of electro-magnets located in the main circuit, and in a shunt circuit, these magnets acting on armatures mounted on a rocking frame in connection with a brake, so as to regulate the feed of the carbons. The patent specification is illustrated with drawings of the machine and lamp.

3771. AN IMPROVEMENT OR IMPROVEMENTS IN THE PRODUCTION OF VOLTAIC ELECTRICITY, *A. Banks, Birmingham.*—*30th August*, 1881. 6*d*.

This consists in the utilisation of the pickling vats in which iron and steel are cleaned, preparatory to being electro-plated, as generators of electricity. The iron sheets placed in the vat to be cleaned are connected by a metal hook to a rod supported on the top of the vat. In the latter are placed one or more upright porous vessels, the tops of which are above the dilute acid in the vat; in these are placed strong nitric acid and carbon plates. These carbon plates are connected by metal wires. Thus the iron acted on by the dilute acid is the analogue of the zinc in an ordinary battery, and the carbon in the nitric acid is the analogue of the carbon in a Bunsen cell.

3799. IMPROVEMENTS IN THE CONSTRUCTION AND MANUFACTURE OF ELECTRIC LAMPS, *W. Crookes, F.R.S., London.*—*31st August*, 1881. 6*d*.

This relates to incandescent lamps. Having blown his glass globe, the inventor, while the neck is still hot, presses the end inwards with a two-pointed metal tool like a fork, so as to make a hollow projection into the neck, terminating in two hollow points of glass. A small glass tube is attached to one of these, by which the lamp can be exhausted. The neck is then cut in two, and the two points are opened so as to admit of the conducting wires being passed through and sealed in each of the projections by means of white enamel or arsenic glass. Each wire has a small cylinder of glass sealed to it, before it is passed through, so that glass is sealed to glass. The carbon is now attached to the wires, and the two portions of the neck are sealed together again. The lamp is then exhausted by the small tube mentioned above. To overcome the difficulty of joining glass and metal, other than platinum, or the cracking of the glass produced by using thin platinum wires, the inventor uses a compound wire, having a core of copper and a platinum sheathing. The inventor tests his carbons in an exhausted receiver, into which, should one or more be below the standard, a hydrocarbon of some kind can be introduced, by means of which the carbon will be thickened.

3821. IMPROVEMENTS IN ELECTRIC LAMPS OR REGULATORS, *A. L. Fyfe, London, and J. Main, Brixton.*—*2nd September*, 1881. 6*d*.

In this lamp the upper carbon is automatically fed forward by a train of wheels, which train is controlled by the current. The carbon holder and train are capable of receiving from an electro-magnet in the main circuit a slight longitudinal movement bodily in the lamp frame, whereby they are raised for the purpose of separating the carbons and establishing the arc, the brake on the train being actuated by another electro-magnet so as to permit the descent of the carbon holder independently of the train for feeding the carbon as it is consumed.

3871. IMPROVEMENTS IN DYNAMO-ELECTRIC MACHINES, *H. A. Harborow, London.*—*6th September*, 1881.—(*Not proceeded with.*) 2*d*.

This consists of a dynamo-machine with two armatures revolving in opposite directions, and independently if required.

4017. IMPROVEMENTS IN ELECTRIC LAMPS, &c. *S. Hallett, London.*—*17th September*, 1881. 4*d*.

This relates to incandescent lamps. The inventor supports his filaments in a foundation of lime, mounted between two platinised carbon discs, and covers the incandescent portion by a shell of silicon, thereby providing an impervious coating against the action of atmospheric gases, or he places the silicon inside a cylinder of lime. The glass globes surrounding the whole are of the usual shape, and exhausted in the ordinary manner.

4019. IMPROVEMENTS IN GENERATING DYNAMIC ELECTRICITY, *G. E. Dering, Lockleys, near Welwyn, Herts.*—*17th September*, 1881. 6*d*.

This invention consists in improvements in the Grove Gas Battery, whereby the inventor converts it into a cheap and powerful generator of electricity. He substitutes atmospheric air for the oxygen gas usually employed as the negative element, and for the positive certain inexpensive oxidisable gases, such as common coal gas, &c. The inventor stores his gases in large reservoirs, from which pipes lead to the various cells of the battery. Instead of using platinised carbon or platinum for the conductor in contact with the negative gas, the inventor employs ordinary coke, and for the positive conductor he uses an alloy of lead, tin, and a small percentage of other metals, coated with platinum or silver. The inventor obtains better results with spiral or coiled conductors than with flat. The liquid used is acidulated water, as in the usual form of battery.

4024. IMPROVEMENTS IN ELECTRIC LAMPS, *W. Morgan Brown, London.*—*19th September*, 1881.—(*A communication from E. M. Fox, New York.*)—(*Not proceeded with.*) 2*d*.

The object of this invention is to facilitate the construction of incandescent lamps by means of an apertured stop plug, through which the air can be drawn off, so as to obtain a vacuum, and the globe subsequently rendered air-tight by simply turning the plug round. This plug is also used as a support for the conducting wires and carbons.

4058. IMPROVEMENTS IN AND RELATING TO ELECTRICAL CABLES OR LINES FOR TELEGRAPHIC, TELEPHONIC, AND OTHER PURPOSES, *H. H. Lake, London.*—*20th September*, 1881.)—(*A communication from B. J. Henck, jun., Boston, U.S.*) 6*d*.

The object of this invention is to overcome the retardation of electrical signals in long cables or lines. This the inventor accomplishes by causing the various sections of his cable or line to overlap one another in such a manner that a charge of electricity entering upon one section immediately begins to produce its inductive effect upon the next section, and so on.

4059. IMPROVEMENTS IN ELECTRICAL BATH APPARATUS TO BE USED FOR THE APPLICATION OF ELECTRICITY TO HORSES AND OTHER ANIMALS, *H. H. Lake, London.*—*20th September*, 1881.—(*A communication from Dr. B. Barda, Vienna.*—(*Not proceeded with.*) 4*d*.

This is an improvement on the electro-magnetic bath appratus described in patent No. 1107, dated 14th March, 1881, so as to render the same applicable for animals, and especially horses.

4093. IMPROVEMENTS IN OR CONNECTED WITH ELECTRIC CABLES, *E. G. Brewer, London.*—*22nd September*, 1881.—(*A communication from P. B. Delany and E. H. Johnson, New York.*—(*Not proceeded with.*) 2*d*.

This invention is intended to avoid the pressure on the wires of a cable enclosed in a lead pipe, whereby their insulation is endangered, which is effected by forming the intervening lead walls, which separate the various wires, of material which is wholly or partly added to the body of the pipe.

4128. IMPROVEMENTS IN THE METHODS AND APPARATUS FOR DISTRIBUTING AND REGULATING THE TRANSMISSION OF ELECTRICAL POWER, *J. Imray, London.*—*24th September*, 1881.—(*A communication from M. Duprez and J. Carpentier, Paris.*) 6*d*.

This invention consists in the regulation of the transmission of power by electricity. Where a number of machines or lights are worked from the main circuit, the use or disuse of one or more affects all the others. To provide against this, the inventors, instead of connecting each of the lights or machines directly to the circuit, connect each of them to one of two secondary batteries which have been charged from the main circuit, the other of the two in the meantime receiving its charge from the circuit so as to be ready for use when the former is exhausted. The patent is illustrated by diagrams of the connections necessary to carry out the invention, the kind of commutator employed, &c. Other means of regulating the current from dynamos are described, consisting principally in the combination of two machines so that the one regulates the other.

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THE EXCHANGE TELEGRAPH COMPANY, LIMITED.

Head Offices--17 & 18, Cornhill, E.C.; Stock Exchange, E.C.; 27, Regent Street, W.

Incorporated the 28th March, 1872, under the Companies Acts of 1862 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

The instruments supplied by the Company can be had to work either on single or double wires, and to print either on a slip or tape of paper, as has hitherto been the custom, or on a broad band of paper in column form.

The Company will supply householders and others with its

DISTRICT CALL SYSTEM.

By the aid of a small automatic telegraph instrument a Subscriber can at any hour, day or night, call a messenger, cab, or policeman, or give the alarm of fire, and will obtain the required assistance within three minutes of making the signal. Subscribers, when absent from their homes for a season, can leave their houses closed, and have them taken charge of by the Company, and rendered perfectly secure against burglars by a telegraphic communication with the nearest District Call Station of the Company, where a policeman will always be in readiness day and night to respond to calls.

Provincial combinations to work under the Company's Patents will be treated liberally.

The Company is also prepared to supply Municipalities with its system of

STREET FIRE ALARMS

as recommended by H. M. Postal Telegraph Department to the Metropolitan Board of Works for the Metropolitan Fire Brigade, and which has received favourable mention by Captain Shaw in his last annual report.

These Alarms have recently been considerably improved by the Company, and are acknowledged to be the simplest yet constructed.

All communications to be addressed to the Secretary as above.

MARSHALL, SONS, & CO., LIMITED,

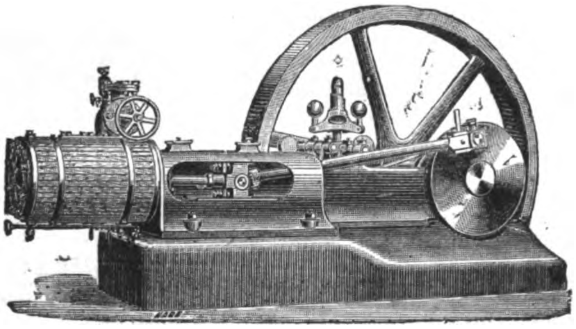
Britannia Iron Works, GAINSBOROUGH, & 3, King Street, Cheapside, LONDON, E.C.

MANUFACTURERS OF

STEAM ENGINES,

Fitted with Patent Automatic Expansion Valve Gear, and

SPECIALLY DESIGNED FOR DRIVING ELECTRIC LIGHT MACHINERY.



OF THE FOLLOWING TYPES:—

HORIZONTAL FIXED ENGINES, with separate Boilers,

HIGH PRESSURE PORTABLE and SEMI-PORTABLE ENGINES,

COMPOUND HIGH and LOW PRESSURE PORTABLE and STATIONARY ENGINES,

As used for driving a large number of the most important Installations in London and the Provinces.

MELBOURNE EXHIBITION, 1881.---Highest Award for all Exhibits. FIVE GOLD MEDALS.
SYDNEY EXHIBITION, 1880.---Two Special First and Four First Prizes.
PARIS EXHIBITION, 1878.---TWO GOLD MEDALS, and other Prizes.

Catalogues in English, French, German, Spanish, or Russian, free on application.

EASTERN TELEGRAPH COMPANY (Limited).—NOTICE IS HEREBY GIVEN, that the TWENTIETH HALF-YEARLY ORDINARY GENERAL MEETING of the EASTERN TELEGRAPH COMPANY (Limited), will be held on THURSDAY, the 13th JULY, 1882, at 2 o'clock in the afternoon, at the Terminus Hotel, Cannon-street, London, when the Report and Accounts of the Directors for the Half-year ending 31st March, 1882, will be presented, a Dividend declared, and the ordinary business of the Company transacted.

At the close of the business of the Ordinary Meeting an EXTRAORDINARY GENERAL MEETING will be held at the same place to consider, and if thought fit, pass Resolutions sactioning the acquisition by the Company of the Trieste Corfu Telegraph Cable and Concession and the laying of a Cable between Malta and Tripoli, and Special Resolutions will be submitted authorising the creation and issue of Mortgage Debenture Stock of the Company to an amount not exceeding one-third of the paid up Share Capital for the time being for redemption of Debentures and other purposes, and regulating the transfer thereof and the powers of the Company in relation to purchasing and dealing with the same.

NOTICE is also given, that the Register of Transfers will be closed from the 6th to the 13th July, both days inclusive.

By order of the Board,

66, Old Broad-street, London, GEORGE DRAPER, Secretary.
5th July, 1882.

TO ELECTRICIANS.—WANTED, by the Birmingham and Warwickshire Electric Light and Power Company (Limited), a thoroughly competent, practical ELECTRICIAN. Application to be made by letter to the MANAGER, 110, Cannon-street, E.C.

WIMBLEDON LOCAL BOARD.

LIGHTING STREET LAMPS.

The Wimbledon Local Board are prepared to receive TENDERS for LIGHTING about 300 STREET LAMPS with gas or otherwise, and lighting and cleaning same at per lamp from the 1st August next to the 31st July, 1883. Lamps to be alight from sunset to 1 a.m. A proportionate deduction to be made from price in respect of each lamp in case of the same not being alight on any night or nights from whatever cause. Penalty of 2s. 6d. per night for each lamp not alight through default of contractor. Formal contract with two sureties required. Payment half-yearly.

Tenders, addressed to me, and endorsed "Tender for Lighting the Street Lamps," to be sent in on or before noon on Tuesday, the 17th July instant.

By order,
W. H. WHITFIELD, Clerk to the Board.

Offices of the Local Board, Wimbledon, 6th July, 1882.

WATER POWER.—To be DISPOSED OF a very large WATER POWER, available for the purpose of Electric Lighting or otherwise. For particulars apply to B. CORCORAN, Jun., 31, Mark-lane, London, E.C. (A. 253.)

INSULATED ELECTRICAL WIRE, Silk, Cotton, or India-rubber covered. Conductivity guaranteed. German Silver Wires for Resistance. Braided Handle Cord, Silk Cord for Electric Bells, &c.—WILLIAM RICKARD, Derby. London Agent (stock kept), EDWIN HOLLOWAY, 2, Gutter-lane, E.C.

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SLIP

CORRESPONDENCE.—A number of letters are this week unavoidably postponed for want of space.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.—This company announce an *ad interim* dividend of 12s. per share.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 30th June amounted to £2,438.

CONSOLIDATED TELEPHONE CONSTRUCTION COMPANY.—This company have declared an interim dividend at the rate of 10 per cent. per annum for the three months ended the 30th ult.

CANADIAN TELEGRAPHS.—The title under which the entire telegraphic system of the Dominion of Canada has been amalgamated is that of the Great North Western Telegraph Company.

PERSONAL.—It is notified that Mr. S. G. H. Barfield has passed the recent examination for D.Sc. at University College, London. His subject was electricity treated experimentally.

ELECTRIC LIGHTING DIFFICULTIES.—It is reported that certain people in Newport, Rhode Island, U.S.A., have been taking advantage of the night to saw down the poles erected for electric light wires in that town.

NEW TELEGRAPH LINE IN AMERICA.—It is stated that the Baltimore and Ohio Telegraph Company is making rapid progress with its new line between New York and Baltimore, which it is expected will be completed by September 1.

TELEPHONY.—We understand that the reports that have appeared in the daily press stating that the bombardment at Alexandria on Tuesday was heard at Malta by means of a telephone connected with the Malta-Alexandria cable, are inaccurate.

THE ELECTRIC LIGHTING BILL.—The House of Commons is to rise for a short autumn recess somewhere about the 8th of August, and it is stated an effort will be made to carry the Electric Lighting Bill through Parliament before the adjournment.

ELECTRIC LIGHT IN NEW YORK.—We learn that the City Hall Park, in New York, is to be lighted regularly every evening by twelve electric lamps supplied by the United States Electric Light Company, at a cost of 70 cents per lamp per night.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 30th June, 1882, were £1,477, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

CUBA SUBMARINE TELEGRAPH COMPANY.—An ordinary general meeting of this company will be held at 61, Old Broad-street, E.C., on the 19th inst., at 1 p.m., to receive the directors' report for the last half year. A copy of this report will be found in another column.

ELECTRIC LIGHT FOR BRIGHTON AQUARIUM.—The Directors of the Brighton Aquarium Company are inviting proposals for lighting up the tanks, corridors, and terraces of the Brighton Aquarium. Further particulars can be had from Mr. J. Wilkinson, manager and secretary.

INSTITUTION OF CIVIL ENGINEERS.—The council of this Institution have awarded to Mr. Alan Brebner, jun., B.Sc., University of Edinburgh, the Miller Scholarship, value £40 a year, for three years, for his paper on "New Forms of Dioptric Apparatus for Electric and Other Flashing Lights."

ELECTRIC LIGHT IN PARIS.—Recently the Municipal Council of Paris decided to light the Monceau Park by means of twelve groups of lights on the Jablochkoff system. An opinion was at the same time expressed in favour of lighting all the important public gardens of Paris by electric light.

ELECTRIC LIGHT IN INDIA.—Sixteen Brush lamps, supplied by the Eastern Electric Light and Power Company have been lighting the Prince's Dock, Bombay, recently. They are to be tried for two months, and if the port trustees are satisfied with the light given, this system is to be adopted permanently.

A POST OFFICE CLERK IN AMERICA.—An American contemporary says:—"Mr. William H. Glover, an operator, formerly employed in the Belfast, Ireland, Postal Telegraph Office, who recently came to this country, has been sent to Chicago to assist in teaching the Wheatstone system to the Western Union operators of that city."

IMPROMPTU ELECTRIC LIGHTING.—During the festivities at Henley-on-Thames consequent on the recent regatta, amongst other things there was to be seen a "roundabout" lighted up, not by the ordinary naphtha lamps, but by two electric arc lamps. This is speculating in electric light with some prospect of a speedy and remunerative return.

GREAT NORTHERN TELEGRAPH COMPANY.—Our Note of last week referring to this company's traffic receipts is somewhat misleading. It should have read as follows:—The traffic receipts of this company for June amounted to £22,560. The total receipts for the months January to June this year were £115,560, as against £114,966 for the corresponding months in 1881, and £108,035 in 1880.

ELECTRIC LIGHT IN THE SEVERN TUNNEL.—We understand that the Great Western Electric Light and Power Company has received an order from the contractor for the Severn Tunnel for dynamo and lamps for lighting up the tunnel during the progress of the works, and that a dynamo to drive forty lights has been sent down, together with its complement of lamps. The Brush system has been in operation for some time at these tunnel works.

TELEGRAPHING FROM LONDON TO INDIA.—Up to about 7 a.m., Egyptian time, or 9 a.m., London time, on Tuesday, the Eastern Telegraph Company's office in Old Broad-street was in direct communication with Bombay, *viâ* the Egyptian land lines, and messages were sent right through from London to Bombay as usual. At this hour, or about then, however, the first shot of the bombardment was fired, and the Egyptians at once cut their land lines and stopped communication.

TELEPHONE COMPANIES.—In the House of Commons, on Thursday week, Mr. Boord asked the Postmaster-General whether he would consider the expediency of granting licenses to more than one telephone company, in order that the public might benefit by competition, as well as by recent and future advances in science. Mr. Fawcett replied that he had already stated the subject was under his consideration, and he could only repeat that there should be no unnecessary delay in arriving at a decision.

ELECTRIC TRANSMISSION OF POWER.—In a recent communication to the Société des Ecoles d'Arts et Metiers, M. J. Chrétien states that the first attempt to transmit motive

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power by electricity was made at the Vienna Exhibition in 1873 by M. H. Fontaine. M. Chrétien thinks that it is safe to calculate upon the transmission of 50 per cent. of the whole power. Solar heat, he thinks, when transformed into electricity, seems to offer a more desirable solution of the problem than its direct application to the production of steam.

Electric Light at Reading.—During the past week the exterior of the premises of Messrs. Sutton and Sons, the well-known seed merchants, in the Market-place, Reading, have been lighted up by a couple of Brush lamps. An exhibition of Maxim incandescent and other electric lamps is, we believe, opened now in the premises of Messrs. Heelas, Sons, and Co., in Broad-street, Reading. The lamps will be supplied, and the machinery, &c., erected by the Electric Light and Power Generator Company, under the superintendence of their manager, Mr. Massey.

Electric Lighting at Godalming. — A somewhat amusing account of electric lighting in Godalming is given by a contemporary, with a note of interrogation after the word lighting. The paper referred to says:—"A fortnight ago all the lights went out, owing to the wires coming in contact with the telegraph wires and destroying them, as well as, it is stated, the instruments at the post office. On Thursday night one of the arc lights was continually failing, but it was promptly roused into action by the police on duty administering a few kicks to the lamp-post."

The Electric Light at Alexandria.—The *Standard* correspondent on Board H.M.S. "Invincible," which was stated to be lying about seven miles from the Eastern Telegraph Company's cable ship "Chiltern," telegraphs as follows, at 9 p.m., on Wednesday night (Egyptian time):—"The 'Chiltern' is endeavouring to obtain replies to the Queen's message about the wounded, by signalling with the electric light to the various vessels of the fleet. The signals can be read with perfect ease, and could be so were the 'Chiltern' lying at several times her present distance."

Overhead Electric Light Wires.—An accident of a peculiar character is reported as having occurred on the night of Friday week at Brighton. While the members of the local volunteer fire brigade were proceeding to a fire with their escape, it came in contact with the electric light wire overhead, and the current descending the wirework of the escape caused those volunteers who had control to loose their hold. Another member, thinking the machine was falling, grasped the steering rod, and received the full force of the shock, which was so powerful as to bend him double, and disable him for upwards of an hour.

Electric Lighting.—In summing up the evidence given before the Select Committee on the Electric Lighting Bill, Mr. J. Fletcher Moulton said:—"We have had witnesses in the box who have told us that so dexterous is the way in which electricity applies heat to illumination, that you have the incandescent electric lamp, the light of which solely comes from heat, giving a light equal to ten times the light that would be given by gas generating the same amount of heat; in other words, the progress of science has enabled us to get ten times as much light out of the same heat by means of this application of electricity."

Electric Light in London.—We believe that the electric light will shortly be introduced into the houses in the neighbourhood of the Adelphi. Messrs. Coutts and Co., the Society of Arts, and other occupiers of houses in the neighbourhood, have already entered into negotiations with the Electric Light and Power Generator Company for the lighting up of their premises by Maxim incandescent lamps, and there is every prospect of the work being carried out. The underground streets and subways already existing in the Adelphi afford an excellent means of laying the cables into the various houses without incurring much expense.

The Mull Telegraph Cable.—A great deal of inconvenience having been experienced in the island of Mull owing to the telegraphic cable between the island and the mainland being broken, strong representations have been made by various parties to the Postmaster-General and also to the county member, Lord Colin Campbell. In answer to these representations a reply has been received from the Postmaster-General stating that "the Department has secured the services of a ship to effect repairs to the Mull cable, and that the vessel will be despatched in a few days." The ship chartered is, we believe, the "Morna," which has already done good service for the Post Office.

Electricity and Coal.—At a recent meeting of the South Staffordshire and East Worcestershire Institute of Mining Engineers, Mr. H. Johnson, jun., vice-president, read a paper "On Electricity and the Utilisation of Small Coal." He said it had been stated over and over again by electricians that they could carry stored electricity without any appreciable loss. If that were so, he saw great advantages to be derived by electricians and coalmasters alike from bringing the motors to the coal instead of taking the coal to the motors. One of the chief advantages to the company supplying the electricity would be the reduced price of fuel at the pit's mouth, and the non-necessity for expensive sites, as in boroughs. The advantage to the coalowners would be a constant demand for the smallest coal or slack, which could not now be sold at a profit.

The Telephone in America.—The reports for the month of May show that the National Bell Telephone Company of Maine gained 78 subscribers during the month, as follows: Lowell, 22; Worcester, 13; Fitchburg, 8; Portland, 15; Lewiston, 10; Bangor, 8; Calais, 1; Bath, 1; making a total of 3,392 subscribers. The Boston and Northern Company added in May a net gain of 99, as follows: Exeter, Portsmouth, and Dover divisions, 31; Salem and Lynn, 45; Lawrence and Haverhill, 17; Newburyport, 2; Nashua, 4; making the total now connected 1,706. The number of communications over the Boston and Northern Company's extra territorial lines during the month was 8,883. The net earnings of the National Bell of Maine for May were 6,300dols., and of the Boston and Northern Company for the same period 3,863dols.—*Operator*.

Electric Light in Amsterdam.—The Grand Café of Krasnapolsky in Amsterdam has been fitted up with sixty "A" lamps on the Edison system as an experiment. Preparations are, we believe, being made for the establishment of a large central station of 5,000 lights, and we are informed that the building for the station has been purchased, and that the work of laying the foundation for six large dynamos will be begun immediately. These machines will be of the same kind as those at Holborn-viaduct. This work is being carried on by a company in Amsterdam, which has been formed for the working of Holland and her provinces. At Krasnapolsky's a fine comparison between gas, arc, and incandescent lighting can be made, as three adjacent rooms are lighted by each separately. As in other cities, the starting of the plant and its first exhibit produced no little excitement amongst the inhabitants. The work is under the charge of Mr. E. G. Acheson, electrician to the Edison Company in Holland and Belgium.

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Deservedly Punished.—At Hammersmith Police Court a few days ago Philip Hillier, a boy living at Kensal New Town, appeared to answer a summons charging him with maliciously damaging some insulators attached to telegraph poles, which were the property of the Postmaster-General. It was proved by a constable that the defendant discharged a stone from a catapult at and broke an insulator attached to the telegraph wires by the side of the canal. The catapult and a number of stones were found upon the defendant. It also appeared that two insulators on the pole were broken. Mr. George Robert Judkin, an inspector of post office telegraphs, informed the magistrates that during the last three years above 3,000 insulators had been broken, at an expense of £172, two-thirds of the damage having been committed between the gasworks at Kensal Green and the Mitre Bridge. Mr. Paget committed the boy for 21 days, refusing an application of his mother to impose a fine. We hope that this will be a lesson to the boy in question and his fellows which will bear fruit. Boys who throw stones at trains or at telegraph posts must be taught, by strong means if milder ones will not avail, what great mischief may result from such amusements.

Electric Lighting of Trains.—Interesting experiments in lighting trains by electricity were recently carried out by the Paris-Lyons and Mediterranean Railway under the direction of Messrs. Jousselin and Mors. The train experimented with was composed of two first-class carriages with break van in front and rear. The front break van and the two carriages alone were lighted by electric light; the van by two Swan incandescent lamps, the carriages, which had four compartments each, by one such lamp in each compartment. Altogether ten Swan lamps were used of twenty candle-power each. The current was supplied by an A Gramme machine, placed in the front van, and which was set in motion by a belt and pulley fixed on one of the axles of the van. The current was not only utilised to feed the lamps, but also to charge Faure accumulators, constructed by M. Reynier. There were thirty of these weighing twelve kilogrammes each. The current from the machine was shunted through the lamps and the accumulators, the latter being charged whilst the train was in motion; at the moment of stoppage an automatic commutator broke the circuit between the dynamo machine and the accumulators, and the latter continued the supply of current to the lamps alone.

A Temperature Regulator.—In a recent number of *La Nature* Dr. Regnard describes the following apparatus for regulating temperature:—"In a bath of water an electrical thermometer is immersed, the upper end of which is open, and in the tube of which a platinum wire dips, which can be raised or lowered, or fixed opposite any particular degree of temperature. The mercury in the bulb of the thermometer is in connection by means of a wire soldered into the glass, with one pole of a Daniel cell, the platinum wire above mentioned being connected by another wire to the other pole of the cell, the circuit being complete when the mercury in the thermometer and the platinum wire are in contact. In the circuit is inserted an electro magnet, the armature of which is furnished with a long lever, which in turn carries a small petroleum lamp. When no current passes this lamp is in position under the bath of water. When a current passes the armature of the magnet is attracted and the lever withdraws the lamp to a distance, and the bath, consequently, is no longer heated by it. Almost immediately the thermometer falls and the mercury breaks contact with the platinum wire the current is at once broken, the electro-magnet becomes inactive, and a spring, acting in opposition to the armature lever, brings back the lamp to its old place under the water bath."

Why the Electric Light Goes Out.—The following reasons are given by Messrs. Siemens Brothers for the failure of certain of thier lamps at different times during the period for which they lighted their district of the City, that is from 1st April, 1881, to 31st March, 1882. We extract the particulars from a report presented to the Commissioners of Sewers by Mr. W. Haywood, their engineer. Accidental falling off of one of the machine belts accounted for the extinguishing of several lights, damage to cable caused by barges passing under London Bridge for others. Then come such items as:—"Soft places in carbons," "strap of exciter broke," "belt of machine slipped off pulley," "burnt dimly on account of soft places in carbons," "spring holding commutator brush gave way," "engine driver letting down steam," "accident to machinery," "breaking of a lace in leathern belt," "short circuited," "strap of machine broke," "an accident occurred at the engine house," "lamps required cleaning," "owing to irregular consumption of lower carbon," "lamps required cleaning, owing to fog and 38½ hours consecutive run," &c. The number of lamps reported as defective during the year in Messrs. Siemens's district was 320, and the total number of hours for which they were defective was 831 hours 54 minutes. 126 lamps are reported to have gone out owing to defective machinery during the year, 34 owing to defective cables, 124 owing to defective carbons, and 36 defects are classed as miscellaneous.

Egyptian Telegraphs.—The following letter from Mr. Frederick George, Deputy Inspector-General of Egyptian Government Telegraphs, appeared in *The Times* for July 13:—"Sir: Referring to a letter signed 'E. A. Floyer,' which appeared in *The Times* of the 19th ult., and the very proper reply given thereto by Sir James Anderson, the managing director of the Eastern Telegraph Company, the following day, I feel it my duty, as the responsible manager of the Egyptain Government Telegraph Service, to explain that no interruption whatever has occurred in the telegraphic communication between Europe and the capital of Egypt in consequence of the temporary closing of the Eastern Company's office at Cairo, as would appear to be implied by the letter above referred to, seeing that messages are daily interchanged between our own and the Company's central station at Alexandria for Cairo. As regards the last paragraph of the letter, I have only to state, from very long experience in the Egyptian Government Telegraph Service, that we have always received every courteous and practical facility from the said company by being allowed free use of their wires when our own communications have been interrupted, and occasionally (as I know personally) to the detriment of their own traffic, so far as slight delays are concerned. Since the temporary closing of the Company's office at Cairo their wires were kindly placed at our disposal, which offer I have gladly availed myself of for the Government service during the unusual and excessive pressure of business, occasioned by the critical state of affairs at present existing in the country." This letter is dated Alexandria, July 3. Both the above letters were reprinted in *The Electrician*.

Thunderstorms.—Severe thunderstorms are reported as having taken place in various parts of the country on Friday last and subsequent days. On Friday evening, between five and six o'clock, a storm burst over the district of Morton, Ringland, and Cossey, in Norfolk. A flash of lightning struck a thatched double cottage at Ringland, occupied by two families, named Fiddy and Bales, and set it on fire. The

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building was burnt down, and two of the occupants severely injured by the flames. On the previous Thursday heavy storms were experienced in Scotland.—On a farm at Balnamoon, near Brechin, two horses that were grazing in a field were struck by lightning, and killed.—During Saturday afternoon a violent storm of thunder and lightning passed over Manchester. About five o'clock, immediately after a vivid flash of lightning, a crash was heard by the occupants of the Wheatsheaf Hotel, situated in High-street, one of the busiest thoroughfares in Manchester, as if timber was falling. The house was full of customers, who had sought shelter from the rain, and a rush was immediately made for all the means of exit, which were, fortunately, numerous. The people had scarcely reached the street when the building fell in bodily. When those present had recovered from the fright into which they had been thrown an examination was made, and it was found that the lightning had struck the roof, which in falling carried all before it, until the house was razed to the ground, leaving only the front wall and the back part of the premises standing, and these were so much damaged that they might fall at any moment. Several persons had very narrow escapes, but, fortunately, no one was hurt. The manager of the house hearing the crash, and coming to an immediate conclusion that the house had been struck by lighting, rushed into the cellar and turned off the gas, fearing that the lightning might fire the house, which contained a large supply of spirits.—At Mapperley, near Nottingham, on the same day, a man and his son were sheltering from the rain in a plantation, when the former was knocked down by a flash of lightning, and rendered insensible. He recovered shortly afterwards, however, and was taken home.

A Submarine Detector.—The importance of being able readily to discover the locality of a submerged torpedo or a metallic obstruction in time of war, or of lost anchors, chains, or electric cables in time of peace can hardly be over-estimated, says *The Times*, and hence the value of a submarine detector the working of which we have recently seen demonstrated. This instrument is the invention of Captain M'Evoy, who is well known in connection with submarine engineering and torpedoes, in which he has from time to time introduced some very marked improvements. The apparatus consists of a small mahogany box, in which there is a pair of coils or bobbins, a vibrator similar to that employed in electric bells for making and breaking contact, and a telephone. To this box is attached a given length of flexible cable, with four conducting wires in it. To the other end of this cable is attached a flat wooden case, in which there are two coils. This case is weighted, so that it will readily sink when placed in the water. There are also terminals on the box for attaching battery wires, and an arrangement for putting on and cutting off the current is provided. There are two complete circuits through the box, cable, and wooden case, the one primary and the other secondary. The battery, the vibrator, one coil in the box and one coil in the wooden case are in the primary circuit, while the telephone, one coil in the box, and one coil in the wooden case are in the secondary circuit. When the battery is on, the coils in the box are adjusted so that little or no noise from the make-and-break action of the vibrator is heard in the telephone. When thus adjusted the instrument is ready for work, and if the wooden case is then brought near a metallic body a loud noise is heard in the telephone, thus indicating the proximity and locality of such a body. The principle upon which this invention is based is that of the induction balance of Professor Hughes. In Captain M'Evoy's apparatus the application of the principle to the detection of the presence of metallic bodies through the sense of hearing has been worked out in a very ingenious and equally practical manner. The instrument cannot fail to prove invaluable in discovering and locating the position of the objects we have mentioned, as well as in indicating the whereabouts of sunken ships, helping to recover treasures, and in assisting generally the operations of divers.

Telegraph Clerks' Grievances.—A meeting of the Leicester Branch of the Postal Telegraph Clerks' Association was held on Saturday evening last, to consider the action of the authorities in calling upon Mr. Crighton, of Liverpool, one of the delegates at the Annual Conference, held at Anderton's Hotel on June 25, to verify statements made at that Conference to the effect that the revision was not a good one, official favouritism having too much to do with its administration, and "that the great majority of the telegraphists were totally ignored, 90 per cent. of them having no immediate benefit."—A Senior Clerk moved the following resolution :—"That this meeting expresses its regret that the Department should have deemed it necessary to attempt to curtail our freedom of speech by calling upon Mr. Crighton to explain his remarks at the Annual Conference, that gentleman having only expressed the opinion of the majority of telegraph clerks, as has been clearly manifested by the reports that have appeared in the public press of numerous meetings held in many different towns, condemning the unjust and partial application of the scheme, and also by the large number of petitions that have been forwarded to the Postmaster-General praying that it might be reconsidered; this meeting, therefore, trusts that the Postmaster-General will grant to telegraph clerks the same freedom to ventilate their grievances that he has hitherto permitted." The mover cited cases which happened at Leicester and Peterborough to support the allegation of official favouritism in the matter of the superior appointments, and said the other statements of Mr. Crighton required but little corroboration. The percentage of the third-class clerks in Leicester who received no immediate benefit from the revision scheme was 83·4, and the fact that the provincial clerks still had to perform an average of two hours per Sunday without remuneration was sufficient to bear out another statement which had been challenged.—The resolution was seconded by another Senior Clerk, and carried unanimously.—Another meeting of telegraph clerks was held on the same day at Birmingham, the object of which was to receive a report on the recent Conference from their delegate, Mr. Haslam, who was thanked for his services. The following resolutions were unanimously adopted:—"That this meeting endorses the resolutions of the Conference, and as there appears to be no means of a satisfactory settlement of the grievances of the postal telegraph clerks except by means of a Select Committee, earnestly appeals to the telegraph staff at all offices to endeavour to secure the support of their Parliamentary representatives to Mr. Macliver's motion." "That this meeting supports the statements of the Liverpool delegate at the Annual Conference in the following clauses as regards this district:—'(1) That the late scheme of revision was applied in an unjust and partial manner, and that official favouritism had to do with its administration. (2) That in the lower classes 10 per cent. only of the staff received substantial benefit. (3) That the scheme of revision is unsatisfactory, because promotions in the future as well as in the past depend principally upon official selection, and not upon any standard of efficiency.'" "That this meeting pledges itself to render all support possible to Mr. Crighton, the Liverpool delegate, should circumstances render it necessary."

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THE CRYSTAL PALACE EXHIBITION.

Post Office Exhibits.

(CONTINUED FROM PAGE 138.)

The *Single-current Duplex Direct Ink-writer* is rather a big title, nevertheless we will try to dissect it. "Single-current" means a mode of sending currents of electricity always in the same direction; "duplex," a method by which the operator at *each* end of a wire can send a message simultaneously; and "direct ink-writer" because the current sent acts upon the receiving recorder directly without any supplementary aid, and writes its characters on a paper ribbon in ink. This apparatus consists of a lever, or *key* for signalling purposes; a galvanometer which indicates the presence or absence of currents, as well as faulty conditions of the circuit; clockwork for drawing the paper tape between two rollers at an uniform speed; an electro-magnet which actuates a lever so as to raise an inking disc into contact with the paper band; a switch for converting the system into *simplex* or *duplex*; and a rheostat, or box containing different lengths of fine wire for interposing various resistances in the path of the current when working duplex so as to represent an artificial line. We learn, then, that Fig. 8 can, by means of a switch, be made to work simplex or duplex, that is, single or double. In the following diagram (Fig. 9) B represents the electro-magnet just below a cylinder of soft iron secured to lever C. The signalling key is at A. The receiving and sending stations are both shown.

Now, if we imagine the current traversing the wire as pointed out by the arrows, it will be seen that all an operator has to do in order to form an electrical circuit is to fill up the small gap at the key marked a and a^1. Short or long depressions of the key make short or long ink signs on the paper; and note further, that the sending clerk does not want his own signals to appear on his own receiving tape. Hence, the fulcrum of the key permits of the receiving instrument being isolated when the key is depressed and the current being sent out to line and the distant instrument. The play of the key is about 1-24 or 1-32 of an inch.

If the ink-writing portion were detached from the magnet and armature lever at *d*, then the simple, comparatively inexpensive, "sounder" instrument would be sufficiently represented. As the free end of the lever plays against the two metallic stops two distinct sounds are heard every time the electro-magnet attracts the armature. Short, or slightly-prolonged intervals between these two sounds indicate the *dots* and *dashes* of the Morse code. Practical experience proves that the ear is as true as the eye; in fact, fewer errors occur from sound reading than from sight, though the signs be actually written. More work can be done when an acoustical *receiver* is employed. It is far easier and quicker to write from dictation when the words emanate from a clear, steady, voice, than it is to write from a copy; and for similar

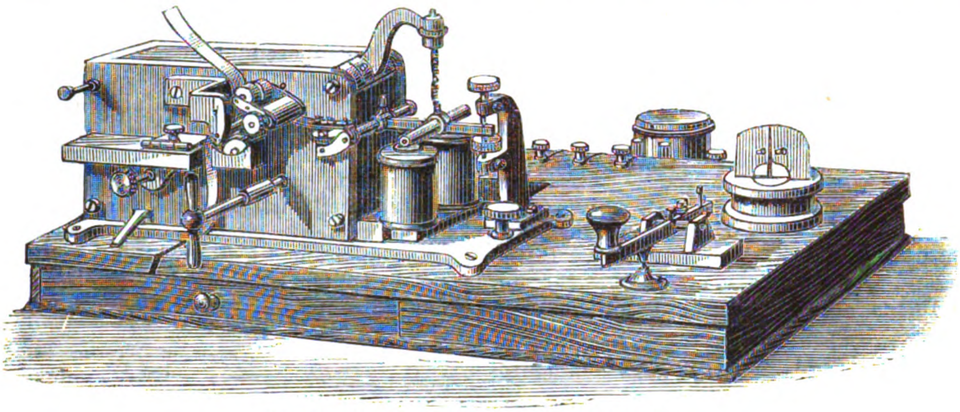

FIG. 8.—Single, or Duplex, Direct Ink-writer.

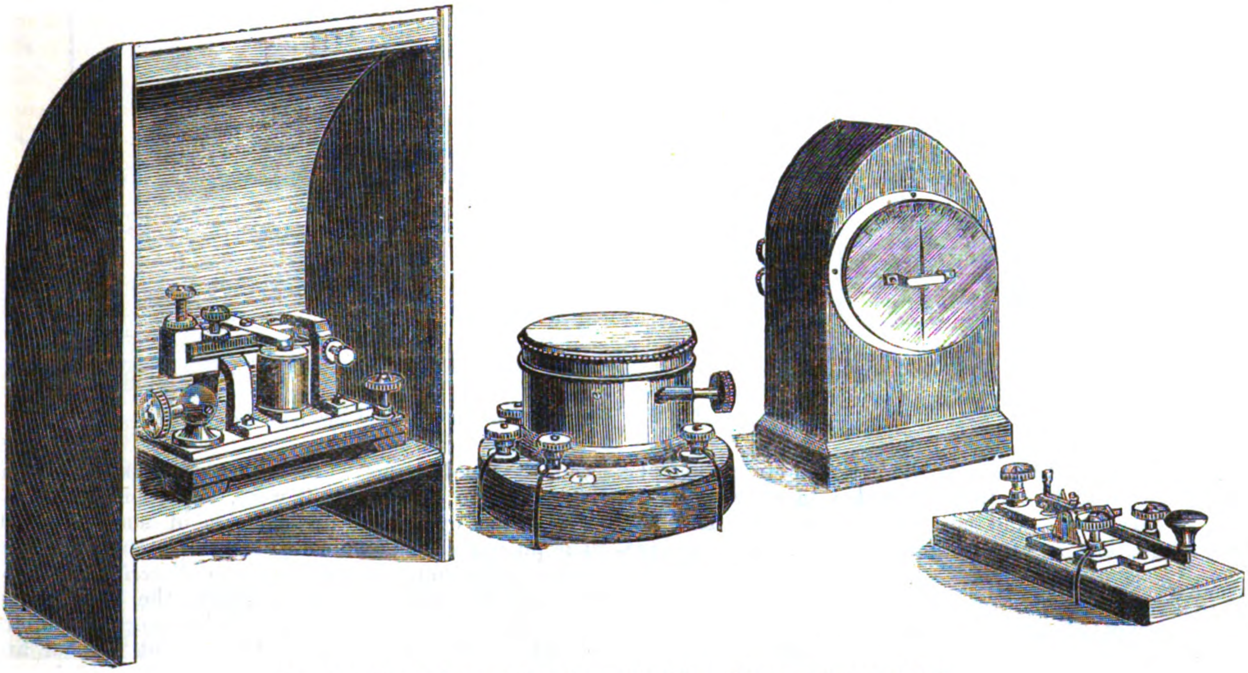

FIG. 10.—Single Current Sounder, with Relay, Galvanometer, and Key.

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reasons an expert clerk can read and write at a speed of thirty-five words a minute from the "sounder."

If the signals of an ink-writer or sounder vary in strength from any cause whatever, or the arriving current be feeble, then a *relay* is added. A relay is a delicate electrical device

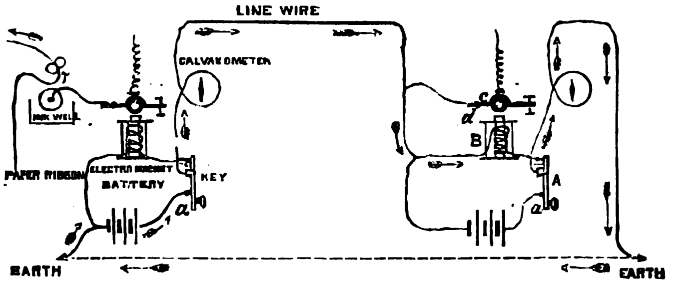

Fig. 9.—Electrical Connections of a Direct Ink-writer, or Sounder Circuit.

which, when operated by a distant station's current, joins up a local battery through the receiving instrument. It thus *repeats* the signals, and the ink-writer, or sounder, therefore responds with the full vigour of the local battery, however can in this way be obtained than if a spring performed the office of the permanent magnet. Fig. 11 is a graphic representation of a working circuit comprising single current sounders, relays, &c., as depicted in Fig. 10.

If we substituted a *double current key* in place of the single current key above, our readers would have before them the *double current sounder circuit.* This key reverses the current after each signal without disconnecting the battery from the line wire, and is put on circuits either defectively insulated (that is, where a considerable proportion of the electricity sent into the wire leaks out to the earth, and is wasted), or on long lines—especially such as consist of both ærial and submarine, or subterranean lengths, or those composed of nearly all gutta percha-covered conductors lying in close proximity to the ground. The key has about 3-16 of an inch play, and is so constructed that during the operation of signalling the current is prolonged so as to produce the necessary charge and a condition of the line suitable for actuating the receiving instruments. Still, the speed of working is slower than on single current circuits, not solely on account of the before-mentioned loss of current, and the longer duration of battery contact for charging the line, but owing to the fact that matter surrounding the wire is influenced by the current,

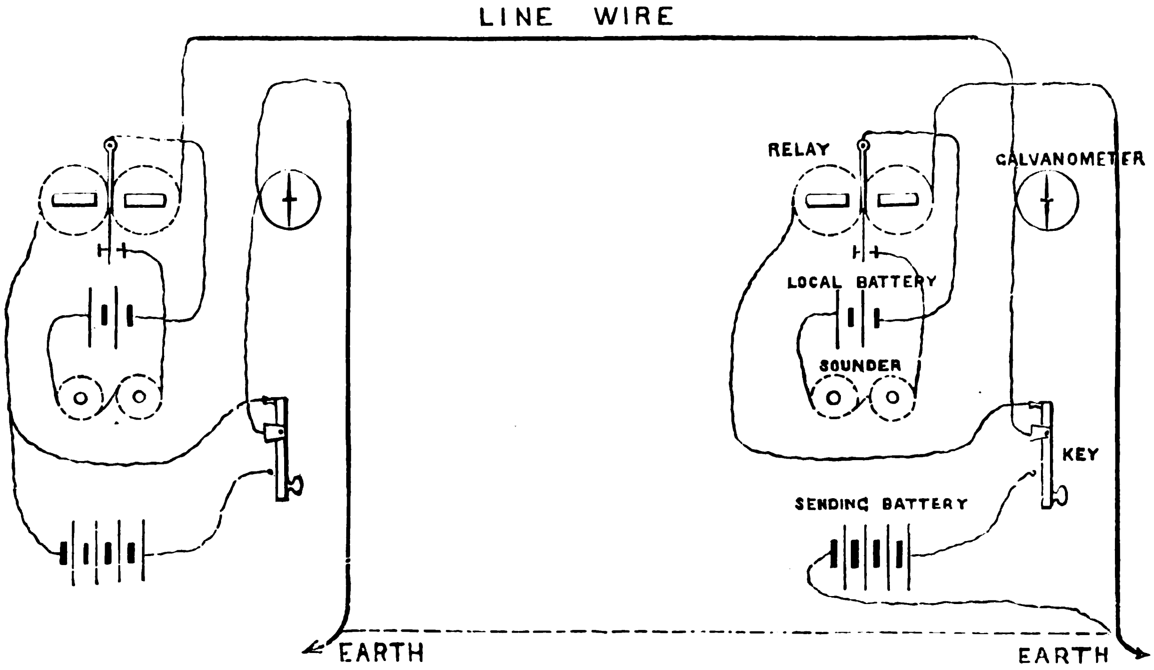

Fig. 11.—Showing Arrangements for a Single Current Sounder and Relay Circuit.

different the electrical effects of the external circuit may be. *Polarised* relays, such as those included in above diagram, contain a permanent and an electro-magnet. The permanent magnetism is an antagonistic force to the electro-

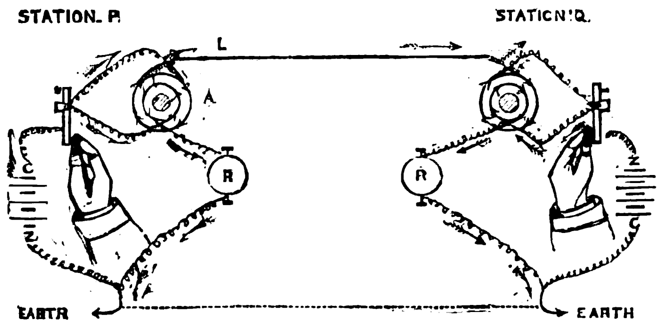

Fig. 12.

magnetic energy, and serves to break the local battery circuit by replacing a light, movable, magnetic bar, after it has been attracted by the electro-magnetism to its position of rest when no current circulates. A much finer adjustment and the dual attractive forces set up cause a portion of the electricity to become, as it were, superficially *bound* on the wire, thus opposing the progress of succeeding currents. The phenomenon is known to telegraph engineers as electrostatic induction. By altering the *direction* of the current through the wire after each signal, the retarding effect is reduced, and, moreover, the electro-magnets in circuit respond quicker; hence a double current key, or any other similar reversing current method, accelerates the transmission of signals over certain lines upon which signalling would otherwise be very slow indeed.

The Duplex, or two-way system of simultaneous transmission in opposite directions on one wire, is not new in principle. Its development was gradual from 1853 to 1872, when, through the exertions of Mr. J. B. Stearns, the system became practicable. He found that the chief impediment was due to electrostatic induction, and surmounted the difficulty by employing in an artificial line an apparatus for accumulating the same electrostatic charge as that on the surface of the line, or, in other words, used a condenser of varying capacities. Fig. 8 represents the class of instrument usually employed for short distances; that used on duplex lines of considerable length will be represented on another occasion.

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The principle of a duplex direct ink-writer (Fig. 12) may be illustrated thus:—

Here we suppose A to be an electro-magnet wound with two lengths of wire instead of one, and joined up in the way shown. Each wire has the same resistance. At R is placed a rheostat (a set of resistance coils, *i.e.*, bobbins of insulated fine wire of known value, or for our present purpose we will say an artificial line). Now, just as water flowing through a main pipe can be caused to supply branch pipes with like or unlike quantities, so with electricity and conducting wires. If station P were sending to Q the current would divide at the fulcrum of his own key between the arms of the circuit R and L, and would move round the distinct coils of wire enclosing the soft iron cores in opposite directions, producing thereby equal and contrary electro-magnetic effects, resulting in the soft iron cores remaining neutral. We have a balance of power, obtained by making the resistance of R, say, equal to L. This so-called balance is indispensable, because while it is essential that the outgoing current shall circulate through the *receiving* instrument at the *sending* end, no self-made signals shall appear upon the home receiving machine, yet the instrument must be ready at any moment to be influenced by the distant operator. Let us, however, proceed:—The current, bifurcated at the fulcrum, half goes through the artificial line R, and half through the real line L on to Q. At Q we find the current traversing the helices in the *same* direction, rendering the cores magnetic and creating a signal. The effect would

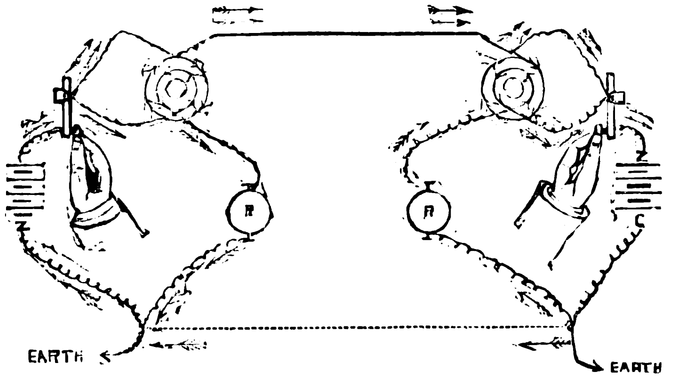


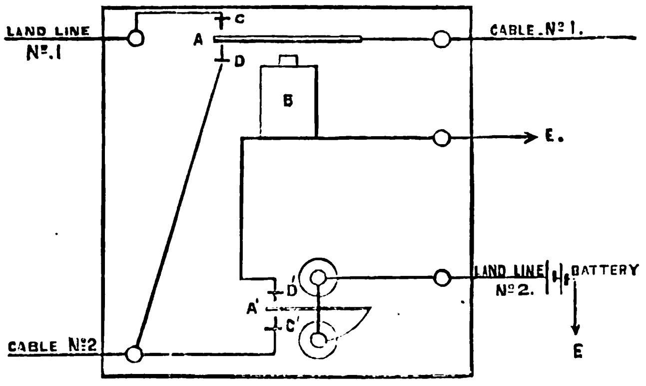
FIG. 13.

be similar if Q signalled to P, but if both operators depressed their key simultaneously then the one battery would help the other, causing the principal current to flow through the coils of wire communicating with the real line; consequently, the balance would be destroyed, the cores would be magnetised, and a signal received at each end of the wire. Fig. 13 indicates the path of the current when two stations send at the same time.

(TO BE CONTINUED.)

Saunders and Kennelly's Cable-house Switch.

The object of this arrangement is to enable an intermediate station (some distance from the landing point of the cable, connected by aerial lines to the cable-house) to either put the aerial lines in connection with the cable for working direct to the terminal stations, or to join the stations through so that the terminal stations could work direct with each other, and thus avoid the inconvenience of badly-insulated aerial wires being in circuit with the cables when the terminal stations were working direct. The action is as follows:—When the land-lines are connected to the cables the armature A of the electro-magnet B rests upon the contact C, putting cable No. 1 direct to land-line No. 1. The tongue A' of the relay rests upon the contact C', and connects cable No. 2 through the coils of the relay to land-line No. 2, the relay tongue being kept over by a spring sufficiently strong not to be affected by the working current. When it is required to join the cables through for direct working between the terminal stations a battery is connected, one pole to land-line No. 2 and the other to earth. This has the effect of throwing the tongue A' of the relay over to contact D', by which the current passes through the electro-magnet B to earth, causing the armature A to make contact with D,



Saunders and Kennelly's Cable House Switch.

thus joining cables 1 and 2 together so long as the battery is kept on. When the battery is taken off the tongue of the relay, A' is drawn by the spring back to contact C', and the armature A on to contact C, thus again connecting the cables to their respective land-lines.

DESCRIPTION OF THE EDISON STEAM DYNAMO.

BY T. A. EDISON, PH.D., AND CHARLES T. PORTER.*

The central Edison station of the first district in New York City will, when fully equipped, be supplied with twelve dynamos, each of which is nominally rated as a 1,200 light machine, at 16 candle-power incandescence, but is capable of supplying 1,400 lights of this power, continuously, and with high economy, without heating the armature, or burning or injuring the commutator or brushes. This increased capacity is due to improvements in the lamp itself.

The armature of each dynamo is driven by a Porter-Allen engine, of $11\frac{3}{16}''$ diameter of cylinder by 16″ stroke, directly connected, and making 350 revolutions per minute, giving a piston travel of 933 feet per minute.

The steam is supplied by eight Babcock and Wilcox boilers, of 2,000 aggregate horse-power, and which will work under a pressure of about 120 pounds. These occupy the basement of the building. Over them, the first and second floors being removed, an iron superstructure is erected entirely separated from the walls of the building, and on this the combined dynamos and engines are placed.

One-half of this equipment is now nearly ready for service, and the remainder is expected to be completed during the coming season.

The armature of the dynamo is of the form commonly known as the Siemens armature, but in its construction and "connecting up" it differs radically from all others.

The foundation of the armature, or the iron core which is built upon the shaft, is made up of sheet iron discs, separated from each other by sheets of tissue paper, and bolted together. This has all the advantages of a solid iron core in strengthening the magnetic field, while it completely prevents the great loss of power by local currents, which would circulate in the iron if it were solid. In the place of insulated wires, the cylindrical face of the armature is made up of heavy copper bars, trapezoidal in section, each bar being insulated and also separated from its neighbours and from the iron core underneath by an air space.

The connection between the bars on opposite sides of the armature, to form the electrical circuit, is made by copper

* A Paper read before the Philadelphia Meeting of the American Society of Mechanical Engineers, April, 1882, and published in the *Journal of the Franklin Institute* for July.

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discs, of the same diameter as the core. At each end of the core are one-half as many of these copper discs as there are bars, each disc being insulated from its neighbours, and the whole being bolted together in such a manner as to form, with the discs of sheet-iron constituting the core, one solid mass. Each disc is formed with projecting lugs on its opposite sides, to which the two bars are connected.

The connections between the opposite surfaces of an armature are of no benefit in generating an electric current, but are a necessary evil, introducing useless resistance into the circuit. By using for this connection copper discs in the manner described a great weight of copper is disposed in a limited space, and so this useless resistance, and consequent loss of energy, is reduced to a minimum.

This method, moreover, reduces the work to a simple machine construction, in which all the parts are duplicates, and the operations can be much cheapened and facilitated by the use of special tools.

The spaces between the armature bars admit of a free circulation of air, thereby preventing the accumulation of heat, and increasing to an enormous degree the capacity of the machine. The armature is at intervals wound with piano wire over the bars to resist the centrifugal force developed by their revolution.

The commutator and brushes of an electrical machine are the parts subject to the greatest depreciation. In this machine all parts of the end of the armature are so constructed as to be easy of access, and they can be quickly and cheaply repaired, or removed and replaced by new parts when necessary. Any accident would require but a short stoppage for repairs.

Provision is made for keeping a continuous and rapid circulation of air over the entire face of the armature.

This armature is 27·8″ in diameter by 61″ long. The commutator adds 18″ to this length, and is itself 12¾″ in diameter. The armature shaft is of steel, 7¾″ in diameter, having a total length of 10′3″. The journals are 6½″ in diameter by 15″ long, and run in Babbit metal bearings in pillow blocks of the box form, giving the greatest stiffness with minimum of weight.

Provision is made for continuous water circulation underneath the boxes, and for continuous lubrication, with traps to prevent the creeping of the oil along the shaft and reaching the commutator, and drains to receive it as it runs through the bearings and convey it to a drip pan.

The magnet is made up of two immense cast-iron "pole pieces," between the semi-cylindrical faces of which the armature revolves, twelve cylindrical soft iron cores attached to these pole pieces, and made magnetic by an electrical current circulated in the wire wound around them, and four soft iron keepers connecting the back ends of the cores. Eight of the cores are attached to the upper pole piece, and four to the lower one.

The width of these "poles" is 49″, and their height 61½″. The length of the twelve soft iron cores is 57″, the diameter of the eight upper ones is 8″, and of the four lower ones 9″.

The four soft iron keepers are each 11″ wide by 9″ in thickness, and the total length of the magnet is 94″.

The magnet is insulated by cast zinc bases 3″ in thickness.

The weight of the dynamo is as follows:—

Armature and shaft	9,800 lbs.
Two pillow blocks	1,340 ,,
Magnet, complete	33,000 ,,
Zinc bases	680 ,,
Total	44,820 lbs.

The copper is distributed as follows:—

In the armature bars	590 lbs.
In the armature discs	1,350 ,,
In the magnet wire	1,500 ,,
Total	3,440 lbs.

Mr. Edison was early impressed with the conviction that to give steady and reliable motion to these armatures it would be necessary to connect an engine to each one of them directly. This combination has been termed by him the steam dynamo.

In adapting the Porter-Allen engine to this service, a special construction in some respects was found to be called for. These special features will be briefly described.

It seemed important to avoid a rigid connection between the engine and the armature shafts, which would require the entire series of bearings to be maintained absolutely in line. In place of this, therefore, a self-adjusting coupling has been introduced, of the form shown in Fig. 1, which will permit of considerable errors of alignment without any abnormal friction being produced in the bearings.

The point of difficulty was the backlash, the engine having no fly-wheel except the heavy armature itself, which was to be driven through the coupling. Provision was made for taking this up by steel keys of a somewhat peculiar form, between which the tongues of the couplings move freely, while they themselves are immovable. These keys are held between set screws threaded in wrought iron rings covering the flanges on the ends of the shaft. All the faces liable to move upon each other are oiled from a central reservoir. This coupling is a very compact affair, without a projection anywhere above its surface, and gives every promise of completely answering its purpose. The engine is made with a forked bed and two shaft bearings and double crank, and so is completely self-contained.

The shaft having no support beyond these bearings on either side, unusual stiffness was required in the crank pin to prevent deflection under the great strains to which it is

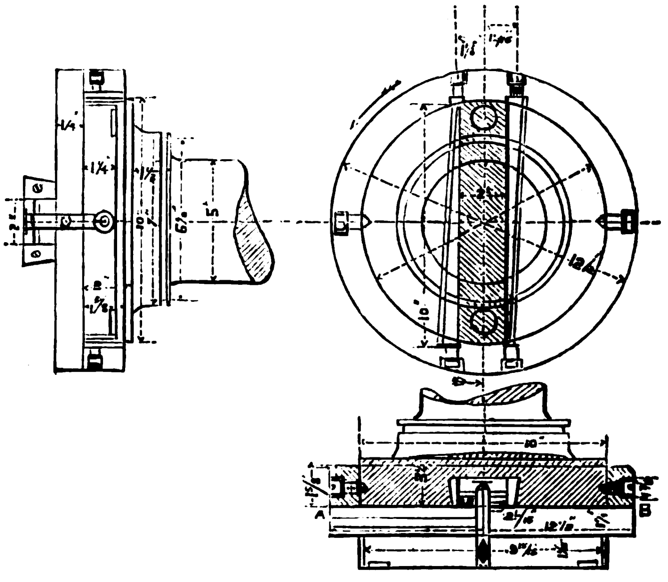

FIG. 1.

subjected. A novel form of pin was proposed by Mr. Richards, which is found to possess all the rigidity required. It is provided with flanges which are let into each crank, and held each by four screws, while the shanks of the pin are also forced firmly into the cranks. Special appliances enabled the work of putting the cranks together in this manner to be done with extreme and uniform accuracy.

The engine is so arranged as to have the valve gear on the side furthest from the dynamo, when running, for any purpose. The connecting rod is of steel, and the crank pin boxes are formed directly in the end of it. This end is finished from a solid forging, and chambered out for Babbit metal. The bolts are then fitted, after which it is parted, and holes are drilled for holding the Babbit securely.

In the connecting rods for single crank engines of this type, permanent length of rod is secured by forming the crank pin end solid, and taking up the wear by a wedge closing up the inside box. In these double crank engines this construction is impracticable, but the same object is attained by forming the crosshead end in such a manner that the strap is made permanent, the inside box being closed up by a key bearing against a steel plate.

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The weight of the reciprocating parts of this engine is as follows:—

Piston, with rod	83 lbs.
Crosshead	42 „
Connecting-rod	109 „
Total	234 lbs.

The initial acceleration of this mass, or the force required, on the dead centres, to give it the motion necessary to relieve the crank from strain, is as follows:—

$$350^2 \times \cdot 66 \times \cdot 000341 = 27\cdot 57,$$

or 27·57 times the weight of the mass, which gives

$$234 \times 27\cdot 57 = 6451 \text{ lbs.}$$

The formula is $R^2\ l\ c$, when

R = the revolutions per minute;
l = the length of the crank in decimals of a foot; and
c = the coefficient of centrifugal force.

The connecting rod is 48in., or 6 cranks, in length. This affects the initial acceleration, making this to be on the dead centre farthest from the crank 7,526 lbs., and on the dead centre nearest to the crank 5,376lb., a difference of 40 per cent.

The area of the cyclinder is 98·2 square inches.

The area of the piston rod, $1\frac{3}{4}$ inches diameter, is 2·4 square inches, leaving area of cylinder at crank end 95·8 square inches.

The initial accelerating forces are therefore as follows, viz.: at the end of the cylinder farthest from the crank 77 lbs., and at the end of the cylinder nearest to the crank 56 lbs., on the square inch of piston area.

The counterweight was after some trials fixed at 135 lbs. This leaves 99 lbs. of the reciprocating parts running unbalanced. It is found that this is not sufficient to disturb the stability of the engine, while on the other hand the counterweight is not so great as to exert an objectionable strain in the vertical direction.

The total weight of the engine is 6,445lbs. The engine and dynamo are mounted on a cast iron base plate, made, for convenience, in two parts, and bolted together.

The dimensions of this base plate are as follows:—Length 14ft., width 8ft. 9in., and its weight is 10,300lbs. The entire weight is is, therefore, as follows:—

Base plate	10,300lbs.
Dynamo	44,800 „
Engine	6,450 „
Total	61,550lbs.

Fig. 2 is a view of the dynamo and engine combined. [Our illustration of the dynamo and engine is taken from one of the combined machines as fixed in the Holborn Viaduct Station of the Edison Company in London, and represents the machine from a somewhat different point of view to that illustrated in the *Journal* of the Franklin Institute. A view of the machine will be found in *The Electrician*, Vol. VIII., p. 202, where also the details of the armature are illustrated and described.—Ed. *E.*]

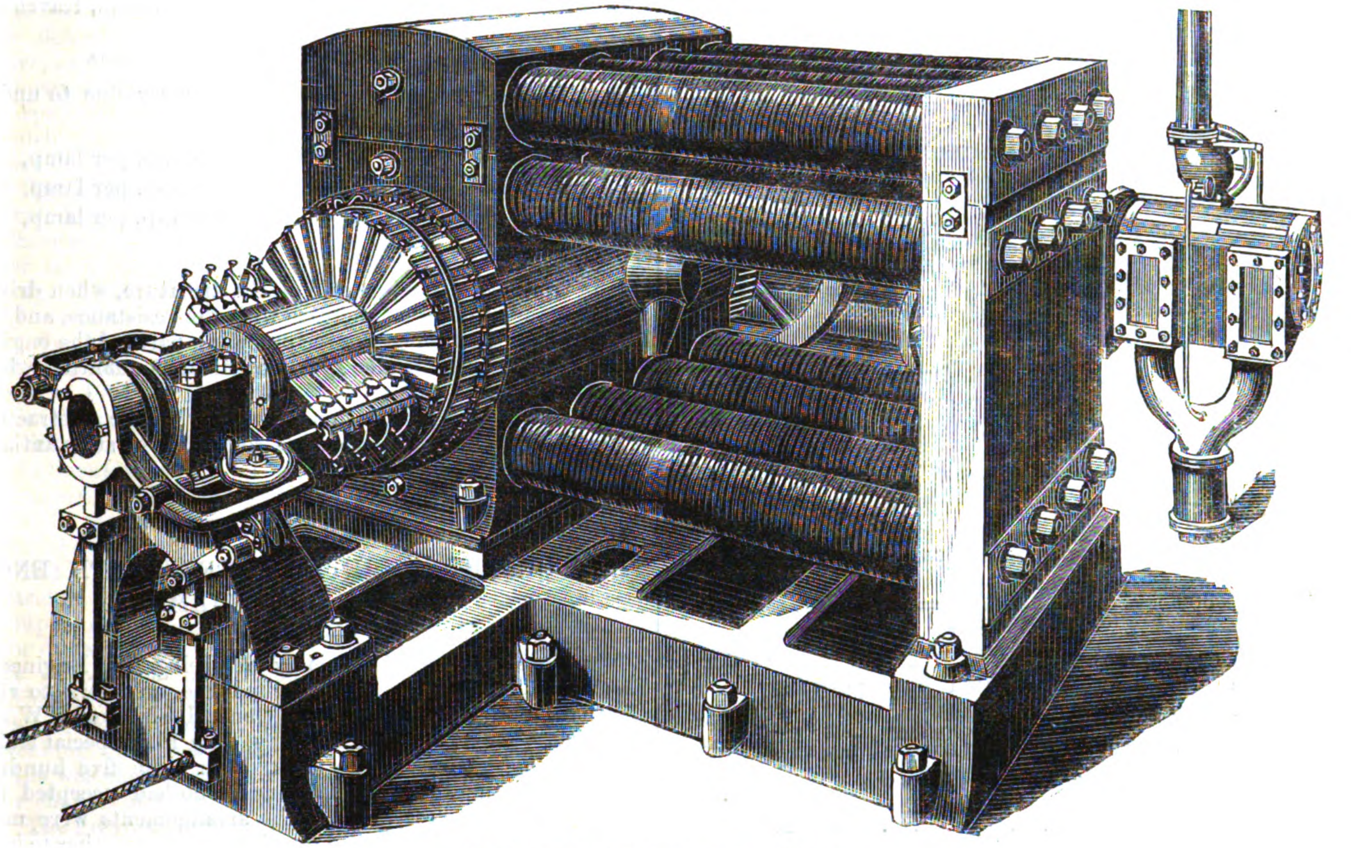

Fig. 2.—Edison's New Dynamo at Holborn.

The last and most careful test of one of these dynamos gives the following results, as shown by the indicator diagrams, which are here reproduced half size; scale 80lb. to the inch. [A note is here appended by the editor of the *Journal* to the following effect:—"As many persons might doubt about these diagrams having been really taken from any engine and by any indicator at this speed, we have examined the originals taken by a Tabor indicator, and can vouch for their accuracy." We may add that the diagrams were given full size in the *Journal*.—Ed. *E.*]

The lamps used in all the trials were of the older construction, of which $8\frac{1}{2}$ lamps, at 16 candle-power incandescence, require 1 horse-power of electrical energy. Since these were placed for experimental uses improvements in the lamp have increased their economy, so that 1 horse-power is sufficient to maintain fully 10 of the present lamps at 16 candle-power incandescence.

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Diagram No. 1 shows the friction of engine and dynamo at 350 revolutions per minute, requiring 13·63 h.-p.

Diagram No. 2 shows the resistance with the magnet circuit on = ... 19·17 h.-p.

Field 5·78 ohms, 103 volts.

The increased resistance due to the magnets was 5·54 h.-p.

Of this, the calculated energy developed in the

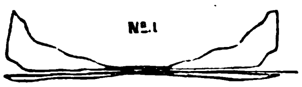
magnets was $\frac{103^2 \times 44{\cdot}3}{5{\cdot}78 \times 33{,}000}$ = ... 2·46 h.-p.

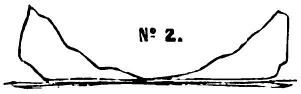
Leaving energy to be accounted for by local currents in iron core of armature, and in armature bars .... 3·08 h.-p.

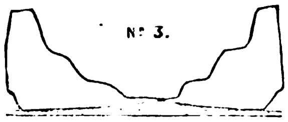
Diagram No. 3 shows the work done in maintaining 300 lamps.

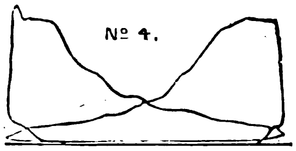
These, in the ratio of $8\frac{1}{2}$ to 10, were equal to 353 lamps of the present construction. The pressure was maintained also at 102 volts, representing 25 candle-power in place of 98 volts, representing 16 candle-power incandescence, which requires the number of lamps to be increased in the ratio of 102^2 to 98^2, or to 382 lamps.

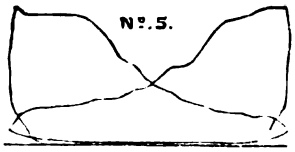
The pressure at the armature was 104 volts, showing a loss in the conductor of 2 volts, which would increase the number of lamps as 104:102.*











The total correction is, therefore, as follows:—

$$300 \times \frac{10}{8{\cdot}5} \times \frac{102^2}{98^2} \times \frac{104}{102} = 389 \text{ lamps.}$$

The power exerted was .... 60·6 h.-p. which gives to the indicated horse-power $389 \div 60{\cdot}6 = 6{\cdot}42$ lamps.

The magnet circuit had now a resistance of 5·28 ohms, with 104 volts pressure, representing

$$\frac{104^2 \times 44{\cdot}3}{5{\cdot}28 \times 33{,}000} = \; . \; . \; . \; . \; . \; . \; 2{\cdot}75 \text{ h.-p.}$$

Substituting this in place of 2·46 h.-p. in the first trial, we have 19·46 h.-p., which, deducted from 60·6 h.-p., leaves net 41·14 h.-p. This gives $389 \div 41{\cdot}14 = 9{\cdot}45$ lamps per h.-p.

Diagram No. 4 shows the work done in maintaining 700 lamps. The pressure at the lamps was maintained, as in the preceding trial, at 102 volts, which required at the armature a pressure of 105 volts. The total correction in this case is, therefore,

$$700 \times \frac{10}{8{\cdot}5} \times \frac{102^2}{98^2} \times \frac{105}{102} = 919 \text{ lamps.}$$

The power exerted was . . . . . 115·83 h.-p.

giving to the indicated horse-power,

$$919 \div 115{\cdot}83 = 7{\cdot}93 \text{ lamps.}$$

The resistance of the magnet circuit was now 4·78 ohms., with 105 volts pressure, representing $\frac{105^2 \times 44{\cdot}3}{4{\cdot}78 \times 33{,}000} = 3{\cdot}1$ h.-p.

Substituting this in place of 2·46 h.-p. in the first trial, we have 19·81, which, deducted from 115·83 h.-p., leaves net 96·02 h.-p. This gives $919 \div 96{\cdot}02 = 9{\cdot}57$ lamps per h.-p.

Diagram No. 5 shows the work done in maintaining 1050 lamps. The pressure at the lamps was maintained in this trial at only 99 volts, but this required at the armature a pressure of 108 volts, showing a loss of 9 volts in conduction. The total correction in this case is thus

$$1050 \times \frac{10}{8{\cdot}5} \times \frac{99^2}{98^2} \times \frac{108}{99} = 1375 \text{ lamps.}$$

The power was .... 168·4 h.-p., giving to the indicated horse-power

$$1375 \div 168{\cdot}4 = 8{\cdot}16 \text{ lamps.}$$

The resistance of the magnet circuit was now 3·28 ohms, with 108 volts pressure, representing

$$\frac{108^2 \times 44{\cdot}3}{3{\cdot}28 \times 23{,}000} = 4{\cdot}77 \text{ h.-p.}$$

Substituting this in place of 2·45 h.-p. in the first trial, we have 21·48 h.-p., which, deducted from 168·4 h.-p., leaves net 146·92 h.-p.

This gives 1375 + 146·92 = 9·36 lamps per h.-p.

It will be seen that the losses of efficiency due to undiscovered resistances are only

In the first case......... $10 - 9{\cdot}45 = {\cdot}55$ h.-p. per lamp,
In the second case ... $10 - 9{\cdot}57 = {\cdot}43$ h.-p. per lamp, and
In the third place...... $10 - 9{\cdot}36 = {\cdot}64$ h.-p. per lamp,

Averaging 5·4 per cent.

The friction in the journals of the armature, when driven in this manner, does not increase with the resistance, and, on account of the action of the reciprocating parts of the engine, that in its bearings is also nearly a constant quantity, whatever the load may be.

The above figures show this very clearly, the subtraction of the friction diagram in each case exhibiting substantially the same net power per lamp.

* The conductors were insufficient, occasioning a loss, that increased with the increase in the number of lamps.

VISIT OF THE SOCIETY OF TELEGRAPH ENGINEERS TO CHATHAM.

The President of the Society of Telegraph Engineers, Lieut.-Colonel Webber, R.E., invited the members to visit Chatham, under permission from General Sir Evelyn Wood. The visit was arranged for Tuesday, July 11. Special trains from Holborn and Victoria took down some five hundred members of the society and friends, who had accepted the invitation to the reception. The arrangements were most admirable, and had it pleased the clerk of the weather to have been a little more propitious, a pleasanter visit could hardly have been made. Even with the disadvantage of a few showers the enjoyment seemed complete.

It may interest those who were unable to be present to have a brief description of what took place. Ample provision of carriages had been made, so that the visitors could drive from the station to the Brompton Barracks, where the reception was held. The rain held off during the drive. On reaching the barracks the guests were divided into parties, each party having an officer as guide. Luncheon was provided, and while one half the party did justice to the viands, the other half was entertained by a lecture on Submarine Mining, delivered by Major Armstrong, R.E., in the lecture theatre. The lecturer briefly described the work of the School, and referred to adverse criticism regarding lack of novelty in the exhibits at the late Exhibition at the Crystal Palace, pointing out that it would be injudicious to make known the novelties designed by their own officers. He admitted that they endeavoured to make themselves conver-

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sant with progress in electrical science so far as information could be obtained, but it was hardly thought wise to publish abroad all the improvements adopted.

A short and graphic history of submarine mines and torpedo work was given, illustrating the recent development of this mode of attack and defence. It was used a little in the Crimean war, but it was not till the American Civil War that any great attention was paid to the system. From then till now it has been constantly and carefully studied. Not only England, but other nations, have erected factories and carried out experiments, and this at considerable risk, for the dangers are great, and accidents frequent. Thus the whole of the Argentine works were destroyed, and not a man within left alive to tell the tale. So again at the nucleous works of the Indian Government, and so on. Thanks, however, to Professor Abel, a past president of the society, the use of gun cotton has become comparatively free from danger, while its manufacture has been carried to a state of great perfection.

A certain number of men (469), aided by some militia officers, are told off for the defence of our military harbours.

The submarine mines used are either permanent or temporary. The former are very expensive, because of the substantial manner in which they must be made if they are not to deteriorate as time passes; the latter are less expensive, and are practically used. Of course, the object of the apparatus is to destroy hostile vessels. The system includes torpedoes, or active apparatus and mines, or passive, inasmuch as the latter are fixed, while the former are caused to move.

The mines are of two kinds, according to the manner of exploding them, which may be mechanical or electrical. Those exploded by mechanical means were described as bad for friend and foe, while the others were dangerous to foes only. Those exploded by electric methods might be exploded by contact, or by (observation) a man completing contact at the right moment. The contact mines contain 100lb. of gun cotton, the observation mines 500lb, the latter being laid in 40 to 50 fathoms of water, and guarding a space of 100ft. diameter.

Several experiments were shown. Thus, 1oz. of gun cotton was burnt to show its harmlessness when not fired by an explosive. An ordinary fuse was exploded, to give some idea of the sound arising. The mechanism of a contact mine was shown, &c.

After the lecture the visitors were taken through the various departments—such as the laboratory, the photographic and the lithographic rooms, the experimental rooms for dynamos, electric light, &c. The workshops were visited, as well as the model shed. The way of making temporary bridges for men, and for men and light artillery, was shown, as was the making of gabions and fascines. Close by the working detachment, the use of gun cotton for destroying rails was shown—a double-headed steel rail being broken up by charges of 11oz. of gun cotton.

The greatest interest was shown in the illustration of the use of larger quantities of explosives. For this purpose a submarine mine, containing 100lb. of gun cotton, was exploded by the contact method. The visitors could plainly see the buoy with which the little steam launch was to make contact, and when the contact was made saw the water rise geyser-like the height of 150ft. or 200ft. Of course the mine was placed at a safe distance from the point of contact. Then a strong stockade of baulks of timber was destroyed by an explosion of gun cotton, the charge being fixed and fired by a firing party, detailed for the work as in active warfare. The last experiment of this kind was the explosion of a mine of 1,000lb of powder, and words cannot describe the grand spectacle of the mass of earth rising gently cloudwards, like a huge fountain, and gradually sinking down again. A procession of steam sappers, then tea and music, concluded the entertainments of the day. We heartily congratulate Col. Webber and his colleagues on the success which attended all their experiments, and we think the members who visited Chatham will look back upon the day as one of the most interesting and enjoyable of the year.

ELECTRIC LIGHTING FOR CAMBERWELL.

Revised Specification.

The roads proposed to be lighted are as follow:—Camberwell-road, from parish boundary, Boundary-lane to Camberwell-green; Church-street, Camberwell; Peckham-road, High-street, Peckham, and Queen's-road, Peckham, to parish boundary at Pomeroy-street.

The conditions are as follow:—The tenderers are to state the situations proposed for the electric lamps, the situations of the conducting wires, and the gas lamps which will not be required whilst the electric light is in operation. The tenderers are especially directed to consider in placing the proposed electric lights, to keep in view the lighting afforded by the present lamps at the corners of the collateral streets, so that such collateral streets in the reduction of the number of the present gas lamps may suffer as little as possible. Should tenders be accepted, the places named are to be lighted nightly, from sunset to sunrise, for 12 months, commencing on the 2nd October next, and terminating on the 1st October, 1883, with power to determine the same as hereinafter provided. The contractor shall also, on the requisition of the surveyor, light the said lamps on occasions of dense fogs during the day. The vestry, in the event of not being satisfied with the performance of the contract and the operations thereunder, reserves the power of determining the contract at any time after the expiration of three months, on giving the contractor four weeks' notice in writing.

The contractor must supply the motive power, electrical machinery, conductors, lamps, carbons, attendance, and everything requisite for lighting the roads during the contract period. This plant will be the property of the contractor, and at the expiration of the contract will have to be removed by him, at his cost. All paving and other property of the vestry disturbed by the contractor are also to be reinstated by him at his cost. The work of fixing conductors, fitting up machinery, lamps, &c., may be commenced within a fortnight after the tender has been accepted and the contract duly signed; and the whole system must be complete and ready for lighting on or before the 2nd October next, on the evening of which day the lighting must commence. The existing lamp columns may be made use of for erecting the electric lamps, or the contractor may erect special columns or posts for that purpose, as may appear to him best. In executing these works, the lamps, apparatus, and means of public lighting by gas are in no way to be disturbed.

Suitable sites for placing the engines and electrical machines must be obtained by the contractor, but it is clearly to be understood that no consent will be given for the appropriation of any part of the public way which is likely in the least to interfere with public or local convenience; the contractor therefore must provide in his estimate for the cost of acquiring such suitable sites for the stations. The contractor must enclose by a suitable shed or building the engines and machinery, provide the requisite foundations for the engines, and all that is requisite for the protection of the machines and motive power. Where pavements are disturbed the contractors will be charged with the re-instatement at the schedule of prices, as follow:—Granite pitching (including concrete), 2s. per yard super.; macadam roadway, 1s. 6d. per yard super.; footway paving, 2d. per foot super.; kerbing, 2d. per foot run. The contractor must be responsible for, and hold the vestry harmless on account of any accident or damage that may arise from imperfect lighting of the public ways, or from laying or fixing conductors and engines, or from any cause whatever which may arise from the carrying out of his contract for electrical lighting. Payments will be made quarterly, in equal instalments upon the total contract price, upon the surveyor's certificate that the contract has been duly fulfilled, but the final payment will not be made until he has certified that the machines, structures, and everything else have been removed, and the pavement made good. The tenders are to be accompanied by an accurate description of the whole system to be employed for the electric lighting. Tenders are to be addressed to the General Purposes Committee, Vestry Hall, Camberwell, before the 17th July, at 4 o'clock, and no tender will be received after that time.

A note is attached to the specification stating that subject to the terms specified therein as between the vestry and the contractor, the contractor shall be at liberty to make such agreements as he may see fit at his own risk for the supply of electric lights to the traders and residents upon the lines of route. Mr. J. C. Reynolds, is surveyor to the vestry, and further information can be obtained from him at the Vestry Hall, Peckham-road, S.E.

New Company.—The Brush Electric Light Company of Ireland has been registered with a capital of £250,000.

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All letters intended for insertion in THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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NOMENCLATURE AND NOTATION.

We have from time to time called attention to the diversity which exists in the names and formulæ generally used in electrical science. Not long ago it was suggested that the Society of Telegraph Engineers should appoint a committee to deal with the matter, but the suggestion was not well received. New books are being continually written and published in which agreement in notation and nomenclature would be of service to the student, but such agreement is looked for in vain. We still believe that the Society of Telegraph Engineers is the proper body to move in this question; and we may point the Council to the precedent of the Institute of Actuaries, a small society comparatively, but one that has, we believe, done more for the profession it represents than any other society existing. A few years ago the notation employed by writers on insurance subjects was as diverse as that used now by writers on electrical subjects. A committee of the Institute considered the question, and a system of notation was drawn up and printed. The system will be found in the Institute Life Tables. The readers of papers before the Institute, and the writers in its *Journal* have to conform to the notation adopted, and it is difficult to find in this country or abroad any work of importance which does not use the system. The Institute "Text Book" just published will assist still further in perpetuating the system adopted. Could not the Society of Telegraph Engineers go and do likewise? The authority of a committee of the society deciding on a notation to be adopted would soon bear fruit. What we have said of notation applies quite as strongly to the question of nomenclature. Middle-aged electricians have had to change the nomenclature half a dozen times probably during the period of active life, and it seems likely, unless a decided stand is made, that the younger generation will also be continually changing. The article of Mr. Phillips, which we print in another column, has some bearing on this subject. It shows the delightful confusion of notation and nomenclature, as will also be known to the reader of recently published works. French and English measurements are given in books and papers indiscriminately. Letters are used in two consecutive pages to mean two different things, different letters are used in different books to mean the same thing. Thus, in the simple formula to illustrate Ohm's law, we get in the translation of M. Hospitalier's book $I = \frac{E}{R}$, while in Clerk Maxwell's the formula reads $C = \frac{E}{R}$, in the one case I having the signification of C in the other. In a book used by students preparing for the London University examination, we find C on one page used to signify "current," on the next to signify "capacity."

We have always been in favour of a notation and a nomenclature that to a certain extent explains itself. Thus, we prefer foot-pound-seconds, to centimetre-gramme-seconds, or metre-gramme seconds. The foot is a length known to every boy from continued observation, as is also the pound in weight, while the length centimetre or metre is known merely in the abstract, never being seen in the lower grade schools, home, or shop. The workmen in our factories, or the workmen who install the electric light, are not collegians; their education has not brought them into contact with the refined scientific methods adopted in these centres of learning. Ask a workman in any factory such a question as, What is a dyne?, and you will obtain a satisfactory reply in, perhaps, one out of a million cases. Yet the "dyne" is not so very new a term, and might have been expected to have been extensively adopted if we consider that it is a term used in Glasgow University. We think the term foot-pound is used so extensively because every one can understand it; whilst the terms which have been suggested or are used as substitutes have not this advantage.

We would urge the Council of the Society of Telegraph Engineers to reconsider whether this is not a subject that can be dealt with satisfactorily and advantageously by a committee appointed for such a purpose. If the society still feels disinclined to undertake the work it will be necessary for some other society to do it. The society should, however, look upon itself as *the* representative body, and not permit any other society to trespass more than has already been done upon its prerogative.

THE TELEGRAPH AND THE BOMBARDMENT OF ALEXANDRIA.

Electric lights of great power were successfully employed on board the "Alexandra," and other war ships before Alexandria, for the purpose of searching the harbour and descrying the operations carried on in the forts during the night-time. The wisdom of the preparations made by the Eastern Telegraph Company for the eventualities of war have been fully demonstrated. For some time past the

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cable has been buoyed a few miles distant from the harbour ready to be picked up and worked at any moment. On Sunday the clerks who had been stationed on one of the war vessels near shore were transferred to the safer position on the "Chiltern," from which post communication with Europe was speedily established. Between her and the Fleet intercourse was then kept up by despatch boats. All commercial messages for Alexandria, however, were temporarily stopped. On Monday the "Chiltern" picked up the Cyprus cable, leaving the Malta cable on board H.M.S. "Helicon." The work of grappling was carried out in a most efficient manner, according to *The Times* correspondent, who says: "The 'Chiltern' signalled at seven o'clock that she had grappled the Cyprus cable. She will next splice it on to the cable which is now attached to the 'Helicon.' The 'Chiltern' is lying about three miles to the westward of the 'Helicon,' and will, perhaps, join the cable before daylight. The 'Helicon' will then proceed to the squadron lying off the forts, to take orders and repeat signals. The fact that the cable was picked up so promptly has given much satisfaction. From the time the 'Chiltern' left her anchorage in the harbour to the time the cable was grappled barely two hours elapsed. Communication was resumed immediately on the cable being got on board." On Tuesday the Company officially notified that their offices at Alexandria and Suez were temporarily closed, and that messages could only be accepted at the sender's risk, as their delivery may not be possible at present. Delay was also to be expected on telegrams for Aden, India, and the South African Stations. During the bombardment of the forts on Tuesday, the "Chiltern" continued moored about four miles distant, having on board the cables communicating with Malta and Cyprus. From this ship the Admiral's secretary continued to transmit intelligence to the Government in London throughout the day and evening. This was kept up with such frequency and speed that, practically, the Ministers may be said to have been spectators of the fray. The daily Press speak in high terms of the arrangements made by the Eastern Telegraph Company to meet these contingencies of war, and especially of the admirable manner in which, under circumstances of the greatest difficulty, the telegraphic service between Alexandria and London has been maintained. "It deserves to be mentioned," says the *Standard* of Wednesday, "that the telegram which we published in our second edition yesterday morning, announcing the commencement of the bombardment, was despatched from Her Majesty's ship 'Invincible' at forty minutes past seven a.m., and was received in London at five minutes past six a.m. (the difference in the time between Alexandria and London being as nearly as may be two hours), so that the message reached this office within about thirty-five minutes from the time it was despatched from Alexandria. The verbal accuracy, too, with which the messages are transmitted deserves the highest praise." *The Times* correspondent also speaks in the highest terms of the company's staff. He says:—"Nothing can exceed the extreme courtesy and attention which have been bestowed upon the public by this hard-working staff, both here (Alexandria) and in Cairo, under very trying circumstances." Wednesday morning's London papers published accounts of the engagement as witnessed from the "Chiltern," and telegraphed almost hourly to the directors of the Eastern Telegraph Company by their agents on board ship. Due precautions, we are glad to notice, are being taken for the protection of the "Chiltern" and her valuable charge. Admiral Seymour has ordered a war ship to cruise round her during the night-time. Up to Thursday morning communication was kept up by way of the "Chiltern," intercourse between it and the Fleet being maintained by means of maritime signalling, the electric light serving this purpose by night. At the time of our going to press news reaches us that the telegraph ship has been ordered inshore, the town of Alexandra having been evacuated by the Egyptian troops, in order to be closer to the Admiral. The Malta and Cyprus cables were, therefore, being spliced, and interruption of communication was to be expected for several hours. Sad news also reaches us that a young Frenchman, named Ternant, one of the *employés* of the Eastern Telegraph Company, who had preferred to remain on shore with his friends, instead of coming off with the rest of the staff, is among the victims of Wednesday night's massacre.

A PRACTICAL STUDY OF ELECTRICAL UNITS.

BY SAMUEL E. PHILLIPS.

This subject, like most others, admits of a double aspect of study, one of simple concreteness, where definite values are easily understood; the other of vast abstractions, where very indefinite values are the subjects of profound disputation.

One is strictly comparable to the simple problem by which a tradesman has to understand his weights and measures, as the other is to a difficult research into the deep origins of history and philosophy.

Any student desirous of ascertaining the simple or concrete facts of chemical, optical, or acoustic science would find that there is no book in existence to supply the desideratum, and precisely thus it is with electricity.

Confining ourselves to one aspect, we offer the following definitions:—

(1.) The unit of E.M.F., or potential, is a *volt*, which in concrete terms is approximatively equal to the force of one Daniell cell (a perfect Daniell cell being 1·079 of the theoretical volt); *potential* in electricity is in every way comparable to *pressure* in water.

(2). The unit of current quantity is a *veber*, or *ampere*. We speak of a current of so many pints or gallons of water *per second*, so in electricity a *veber* or *ampere* is that quantity which liberates ·000,158 grain of hydrogen per second, or does other equivalent chemical work. This is equal to one grain in 6,338 seconds. It is well to bear in mind this additional *time* unit, because it leads us to the truth and simplicity of Nature's units. Thus a veber or ampere current in unit time liberates a *grain-equivalent* of any element—that is, hydrogen 1, zinc 32·5, copper 31·7, silver 108, &c., &c. For practical purposes it may be worth remembering that this means 18·5 grains of zinc per hour.

(3.) The unit of static quantity is a *farad*, or that quantity which, if discharged through one ohm in one second, would give a veber current. Some prefer to regard it as an unit of *capacity*, referring to the vessel rather than to its contents, where one volt of force may charge a given condenser with one farad of quantity. As the veber current necessarily implies time, so the static farad equally implies potential, because two volts would charge the same condensor with a double quantity.

(4) The unit of resistance is an *ohm*, which is concretely represented by 129 yards of pure copper $\frac{1}{16}$in. diameter ($=62\frac{1}{2}$ mils., or ·0625 in.), offering a resistance of 1 ohm. These different quantities are so related that 1 volt, through 1 ohm, gives a *veber* current during 1 second, $\frac{E}{R}=C$.

Such are the principal units, and by their aid the most useful equations can be formed. It is necessary, however, to combine their use with some of the principal physical units, and, writing from the point of view of a butcher or grocer electrician, I would lament the scholastic confusion involved in so many different units.

Representing E.M.F. or potential by E, current by C, re-

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sistance by R, heat by H, and work by W, &c., where each writer uses different symbols, and where the term "intensity" is used to express relations of *pure* quantity, we may note the following useful equations, $\frac{\text{E in volts}}{\text{R in ohms}} = \text{C in vebers}$, which simply means that the amount of current is *directly* as the potential, and *inversely* as the resistance offered in the circuit.

The total energy of a circuit expressed in heat or work units is (*a*) 1 volt × 1 veber = ·000955 "pound Fahrenheit" units of heat per second, or (*b*) 1^2 vebers × 1 ohm = ·737335 "foot pounds" of work per second; or multiplying these unit values by 6338 seconds, we have 6·053 units of heat, or 4673 foot pounds of work for the time of one grain equivalent, or in still further generality we may state the same thing thus :—

Volts × vebers × ·000955 = units of heat per second, or, the square of vebers × ohms × ·737335 = units of work per second; so that, in English terms, 6·053 heat units when converted into work = 4,673 foot-pounds; or, to heat 1lb. of water 1° F. requires an expenditure of energy equal to 772 foot-pounds. Or, to still further elucidate these relations, we may say,

	Vebers. Ohm.		
If in (*b*) case	$1^2 \times 1$	= ·737335 foot-pounds, then	
	$8^2 \times 8{\cdot}6$	= 550 foot-pounds per sec.	= 1 H.-P.
or (*a*),	8 × 93·25 volts ÷ 746		= 1 H.-P.

As the same principles apply equally to the whole circuit or to any part thereof, we give another illustration of (*a*) from a recent research of Mr. Jamieson upon a No. 6 Swan lamp under varied conditions. Measuring the quantity of current passing (the force or intensity of a current in no way affects a galvanometer, which measures quantity only), and otherwise, the force or potential at the two lamp terminals, we have (*a*) = the heat expended in the lamp, or (*a*) ÷ 746 = the H.-P. of energy involved in that part of the circuit.

We cite four cases from an extended table :—

	Volts.		Amperes.		Amperes of 1 Volt.		Heat Units per Ampere.		Total Heat Units.		
A	14	×	·23	=	3·92		—		—		Dull red heat.
B	27·5	×	·66	=	18·15		—		—		Bright red heat.
C	41·7	×	1·13	=	47·12	×	·000955	=	·45	=	4 candles, &c.
{ D	63·3	×	1·9	=	120·27	×	,,	=	1·148	=	50 candles, &c.
{ or	33·33	×	$1{\cdot}9^2$	=	120·27	÷	746	=	·161 h.p.		

In this endeavour towards an uniform consistency we have violated a fashionable empiricism, where English and French units are mixed up in perplexing confusion.

Now, before entering upon other than English units, I would express indebtedness to Mr. Sprague, whose clear intellect and original intrepidity are exceedingly refreshing. It may be from inferior powers that I cannot follow him in all particulars, but speaking again of the fashionable "intensity," he says, p. 148, referring to "*current*-quantity symbolised by C, this is commonly called 'intensity of current,' and is symbolised by I.

"This mongrel term, derived from the translators of the French phrase '*intensité de courant*' (strength or amount of current), leads to great confusion of ideas, because 'intensity' has in the earlier English books a distinct meaning, which corresponds to '*tension*,' and has no connection with *current* or *quantity*."

Of the French metric system, he observes, "It is none the less arbitrary, the only advantage lies in the decimal system simplifying calculations."

One word as to the heat or work being as the square of the current. This should be clearly grasped, not as a technicality, but as an inherent law in the nature of things generally. A given head of water, or hydraulic *potential*, will cause a certain flow of water through a pipe of given resistance, and apart from friction we may suppose it operating a paddle wheel with a given velocity. A double height of column, or double pressure would, through an equal resistance, give a double quantity in the same time, with double force, and therefore drive the wheel with fourfold energy or velocity.

It is precisely thus with electricity, where the principle admits of still clearer illustration :

$$\frac{1\text{ volt}}{1\text{ ohm}} = 1\text{ veber} = 4{,}673\text{ foot-pounds in }6{,}338\text{ seconds,}$$

$$\frac{2\text{ volts}}{1\text{ ohm}} = 2\text{ vebers} = 18{,}692 \quad \text{,,} \quad \text{,,}$$

Here the currents are related as 1 to 2, and the total energies as 1 to 4. One would charge a given condenser with 1 of quantity, say 1 farad of one-fold force; the other would charge the same condenser with double quantity and four-fold force; the opposing surfaces would each have a double quantity of double tension, and, therefore, the attractive force would be fourfold.

Now, let us see that a double current really involves a fourfold cost or consumption of zinc :

One Daniell cell with a resistance of 1 *ohm.*

$$\frac{1\ \text{E}}{1\ \text{R}} = 1\text{ veber} = 4{,}673\text{ foot-pounds} = 32{\cdot}5\text{ grains of zinc,}$$
consumed in 6,338 seconds.

Two larger cells of half internal resistance.

$$\frac{2\ \text{E}}{1\ \text{R}} = 2\text{ vebers} = 18{,}692\text{ foot-pounds} = 130\text{ grains of zinc,}$$
consumed in 6,338 seconds.

Each cell would work under a double tension, and therefore give a double current and double consumption of zinc *in each cell*, making 130 grains instead of 32·5.

Now why have we deferred all mention hitherto of the French *coulomb?* Because it seems an *unnecessary* complication. We speak of a current of so many gallons of water per second, and this, × by the time in seconds, must give any desired totality of *gallons*.

If we similarly × the vebers by the time in seconds, the result must be *vebers*, or *amperes*, but these are now called *coulombs*.

In our treatment of the Jamieson experiments, we similarly × the volts by amperes, which must give a total of *one volt amperes*. Nor would it help matters to call these by a new-fangled name. Any equation must be valuable or appropriate in proportion as it enables a student to understand the essential *rationale* of the process. Gallons × must be gallons, just as amperes × must be *amperes*, but call either of these by quite different name, and the student is compelled to think of the unmeaning name rather than of the essential reality. Every derivative value or useful application derived from *coulombs* must necessarily spring from, and arise out of, *amperes*.

An *ampere* liberates ·000158 grains of H per second, &c., and in every particular does precisely what a *coulomb* does.

It may be, and indeed is, alleged that an ampere is an ampere per second, and a *coulomb* is an abstract *ampere* apart from time, but the definition is equivocal, and proceeds from a mistaken basis. Gallons *per second*, as *applied to current*, are none the less gallons; and amperes per second, as applied to current, are none the less *amperes*. The time function is an adjunct, and not a necessary or invariable constituent.

The English calory or heat unit	= 1lb. of water raised 1° F.	= 772 ft.-lb.
sometimes the unit employed	= 1lb. of water raised 1° C.	= 1389·6 ft.-lb.
The French calorie	= 1 gr. of water raised 1° C.	= ·425 gr. met.
or more commonly	= 1 klg. of water raised 1° C.	= 425 kilog.

As the English calory is equal in mechanical energy to lifting 772 pounds one foot high, so the French calorie (in the latter case) is equal to lifting 425 kilogrammes one metre high :—

A kilogramme = 2·2lb. (2·2046215); the metre = 39·37 inches (3·2808992ft.)
The kilogramme C° unit = 3072·75 foot-pounds.

The following comparisons may be useful in further elucidating these relations :—

Volts.		Amperes.		Volt Amperos.				Kilog.-meters.				Foot-pounds.	
88·33	×	·646	=	57·08	÷	9·81	=	5·819	×	7·23	=	42·07	(*a*)
								H.-P.					
88·33	×	·646	=	57·08	÷	746	=	·076	×	550	=	42·07	(*b*)
								Total heat units.					
88·33	×	·646	=	57·08	×	·000955	=	·0545	×	772	=	42·07	(*c*)
88·33	×	·646	=	57·08	×	·2405	=	13·727	×	3·073	=	42·18	(*d*)
88·33	×	·646	=	57·08	×	·737335	=					42·07	(*e*)

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(*a*) 1 kilogrammetre = 7·23 foot-pounds because 1 kilo. × 1 metre = 7·23.

(*b*) As all these values imply *per second*, so 550 is the 60th part of 33,000 foot-pounds per minute.

(*c*) As the English heat unit is worth 772 foot-pounds, so the total heat units × by 772 = total foot-pounds.

(*d*) 1 volt through 1 ohm in one second = one ampere or a volt ampere; and one ampere of current generates ·000955 English units of heat, or ·2405 French gram. C° unit where each unit is equivalent to 3·073 foot-pounds.

(*e*) The volt ampere is worth ·737335 foot-pounds, therefore 57·08 amperes = 42·08 foot-pounds. It only remains to add that most of these values must be taken as approximative, especially so in regard to their decimal parts. We have followed Mr. Sprague and most books in liberating ·000158 grains of H, per *veber* of current; but there are other determinations, and some prefer to consider that value as ·000162.

ELECTRICAL ACCUMULATORS OR SECONDARY BATTERIES.*

BY PROFESSOR OLIVER J. LODGE, D.SC.

No. V.

(CONTINUED FROM PAGE 158.)

I now proceed to the complete investigation of the most advantageous conditions when charging a set of similar secondary batteries with a shunt dynamo driven at a constant speed:—

Let P be the horse-power actually applied to the driving of the dynamo when it is in full action, at the given speed, as determined by a dynamometer.

Let P^1 be the power required to drive the dynamo at the same speed when it is not allowed to produce any current whatever; that is, the power necessary to overcome the friction and the resistance of the air. So that $P - P^1$ is the whole horse-power available for electrical purposes, and of this some will be expended in heating the armature and field magnet wires.

Let A be the resistance of the armature wire in ohms.
B the resistance of the wire on the field magnets.
R the resistance of the leading wires conveying the current to the cells.
r the resistance of each of the cells.

Let N ($= n\,m$) be the number of cells being charged—arranged n tandem and m abreast.
e the maximum electromotive force in each cell opposing the charging current in volts.
c the current flowing through each cell in Ampères.
b the current flowing through the field magnets of the dynamo.
E the difference of potential between the terminals of the dynamo when it is in action charging the cells.

Of these quantities it is essential that E shall be greater than $n\,e$ if the cells are to be charged at all. If $n\,e$ is the greater they are slowly discharging themselves through the dynamo and are helping to turn it. The nearer $n\,e$ comes up to E the easier will it be for the engine to drive the dynamo, and as soon as $n\,e$ exceeds E it will begin to drive the engine instead of the engine driving it. If the engine strap is slipped the dynamo will go on turning at the expense of the now discharging battery in the same direction as when it was charging it.

The following relations hold among the above quantities:—

$$E = n\,e + n\,r\,c + m\,R\,c \quad (1)$$
$$E = B\,b \quad (2)$$
$$746\,(P - P^1) = E\,(m\,c + b) + A\,(m\,c + b)^2 \quad (3)$$
$$E + A\,(m\,c + b) = \Phi\,(b) \quad (4)$$

The last being a statement that the whole electromotive force generated by the revolving armature is a function of the current flowing round the field magnet; but what that function is depends upon the construction of the machine, and especially upon how near the iron of the magnets is to being saturated. If it is saturated the function is a constant; if it is nowhere near saturation, the function is simple proportion. It can be determined by experiment and plotted.

Of all the above quantities,

P^1 has a fixed value determined by the speed employed, and ascertainable by direct measurement.

e and r may also be taken as fixed and known quantities, for the size of the cell is a matter of convenience, and this determines r; while e is a function of the materials used in the cells, and for Planté or Faure it is about $2\frac{1}{2}$ volts.

R is easily measured, and can be made as small as convenient.

A and B are also easily measurable, and though not uncontrollable, must yet be considered fixed for a particular dynamo.

n and m are of course completely under control, and we have to determine what is the most economical ratio $n : m$. But at present they can be regarded as given quantities.

The remaining four of the above quantities, viz., c b, P, and E, are dependent variables, and are given in terms of the others by the preceding four equations.

The number of thermal units (water—gramme—degree—centigrade) produced every second is:—

At the bearings and in the air churned by the machine, $178\,P^1$;

in the armature $\frac{A}{4{\cdot}2}\,(m\,c + b)^2$;

in the field magnet $\frac{E^2}{4{\cdot}2\,B}$;

in the cells $\frac{1}{4{\cdot}2}\,N\,r\,c^2$;

in the leading wire $\frac{1}{4{\cdot}2}\,R\,m^2\,c^2$;

The energy utilised as chemical work is $N\,e\,c$.

What we want of course is to make this last term as great as possible in comparison with the preceding five terms. Now it must be obvious that the smaller P^1 and R can be got the better. It also appears from the second and third of the above terms that it is good to have A small and B large. But what about N? N appears as loss only in the fourth term, and as gain in the the sixth; hence it must be advantageous to make N large. But then N contains two factors, n and m; and the second of them appears squared in two of the above loss terms; hence, though it is good to have n as large as possible, it is quite a question how big m should be. We find, however, by a little calculation, that to make $N\,e\,c$ as large as possible, compared with the other terms, that is, to make the ratio of useful work to the waste a maximum, we must have—

$$\frac{m}{n} = \left(r + \frac{e}{c}\right)\left(\frac{A + B}{B^2\,(A + R) + 2\,A\,B\,R + R^2\,(A + B)}\right)^{\frac{1}{2}} \quad . \quad (5)$$

or since R and A are, in practice, small, compared with B, we may say that the best possible value of the ratio $m : n$ is very approximately

$$\frac{m}{n} = \frac{e + r\,c}{B\,c}\sqrt{\left(\frac{A + B}{A + R}\right)} \quad . \; . \; . \; . \quad (5^1)$$

We perceive, therefore, that the best value of m depends upon c. If the current flowing through each cell is very weak, a large number may be arranged abreast; but if c is pretty strong m must not be great. Now, the permissible value of c depends entirely upon the size of the cell, for it is the "intensity," or as some call it the "density," of current —that is the current per unit area of electrode—which is to be kept small. But though a very small current is economical, not only because it reduces the waste heat, but, more important still, because it allows the chemical changes to go on slowly and steadily without evolution of gas or secondary disturbances; yet in practice a charging current of only one ampere through large cells would be felt to be somewhat tedious, and an allowance of five amperes would still be very moderate.

I will therefore suppose that the actual value of c is deter-

* We reprint these excellent articles from the *Engineer*.

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mined by practical convenience, and is measured by a galvanometer. Equation (5^1) fixes the best value of m in terms of n—but what is the best value of n? The equations indicate that the nearer $n\,e$ is to its maximum permissible value the better. The maximum value is

$$E_0 = \Phi\,(b_0) - A\,b_0 \qquad (6)$$

But if it is too near this value, not only will the charging be very slow, but, unless the engine is absolutely steady, there will be a risk of the cells sometimes helping to drive it. It need not be so very far short of this upper limit, however, for the current tapped through the outer circuit ($m\,c$) will not be usually great enough to reduce b much below its maximum value b_0, nor E much below E ; and so we may put pretty nearly

$$\begin{aligned} n\,e &< E_0 - A\ m\,c \\ &= Bb - A\ m\,c \end{aligned} \qquad (7)$$

Or putting in the best value of m from (5^1) we get

$$n = \frac{b\,B^2\sqrt{(A + R)}}{e\,B\sqrt{(A + R)} + (e + r\,c)\,A\sqrt{(A + B)}} \qquad (8)$$

The current through the field magnet which enters into this expression is not an absolute constant, even at a given speed, since it depends somewhat upon how much current is tapped off through the outer circuit—that is, upon $m\,c$. Nevertheless, if the wire on the magnet has a properly high resistance, it will be found that b is very nearly independent of $m\,c$, unless the latter is enormous. And as we have expressly said that $m\,c$ is not to be very great, we may regard the value of b at the given speed as nearly constant, and may measure it with a galvanometer.

Practically the value of n would be determined by adding to the series of cells until the current is brought down to the desired small value, taking care that the limit E is not too nearly approached, for fear that a diminution in the speed of the engine might cause it to fall below $n\,e$.

Observe that the greater n is the greater m may be too, so as to maintain the most economical ratio (5).

ELECTRIC LIGHTING FOR THE CITY.

According to a report recently presented to the City Commissioners of Sewers by their Streets Committee, the question of extending the electric light to the eastern portion of the City came before them so far back as the 22nd of March and 25th October, 1881, in the shape of memorials from the inhabitants of Leadenhall-street, Fenchurch-street, and Billiter-street, and from the Portsoken Ward Association. The matter again cropped up on the 7th February, 1882, and in the end the engineer, Mr. William Haywood, was instructed to prepare plans and conditions for "further experiments in electric lighting, not only in the east but also in the north and west of the City, and it was agreed to form four districts for the purpose of inviting tenders for such work." As most of our readers will remember, tenders were invited, and were to be sent in by the 12th May.

The districts to be lighted were as follow:—

District No. 1, comprising St. Martin's-le-Grand, Aldersgate-street, Long-lane (between Aldersgate-street and Smithfield), Smithfield, east side (between Long-lane and Giltspur-street), Giltspur-street, and Newgate-street.

District No. 2, comprising Cornhill, Bishopsgate-street (between Cornhill and Liverpool-street), Liverpool-street (between Bishopsgate-street and New Broad-street), New Broad-street, Old Broad-street, and Threadneedle-street (between Old Broad-street and the front of the Royal Exchange).

District No. 3, comprising Lombard-street, Fenchurch-street, Aldgate, Aldgate High-street, and Leadenhall-street, and

District No. 4, which is identical with the district lighted last year by Messrs. Siemens, and which comprises London Bridge, Queen-street (between Queen Victoria-street and Cheapside), Cheapside (between King-street and Poultry), King-street, Guildhall-yard, Poultry, Mansion House-street, Royal Exchange (open space in front of), King William-street, and Adelaide-place.

The following abstract of the tenders received, prepared by Mr. Haywood, shows the minimum and maximum cost of lighting by electricity as stated in such tenders, compared with the present cost of gas lighting:—

In District No. 1, the tenders varied from £2,190 to £5,750, as against £551 the present cost of gas.

In District No. 2, the tenders varied from £2,350 to £4,270, as against £363 for gas.

In District No. 3, the tenders varied from £2,470 to £3,800, as against £341 for gas.

In District No. 4 the tenders varied from £2,920 to £4,350, as against £612, the present cost of gas.

The report concludes as follows:—"Looking at the experiments which the commission have already carried out, and the great cost of extending the same, as shown by the offers now submitted, we are not prepared to recommend Your Honourable Court to proceed further in the matter at present; the more so as by the Bill now before Parliament, and draft amendments suggested by the Board of Trade, it is proposed to give power to the local authorities to supply electricity not only for public but for private purposes, or to acquire compulsorily the undertakings of other parties after fifteen years from the passing of the Act under which they may be empowered; and until Parliament has decided the principle upon which electric lighting generally shall be permitted we consider it undesirable to incur further expense beyond that to which the commission are already committed by the experiments now in operation."

This report and recommendation was adopted at a meeting of the Commissioners of Sewers held on the 20th of June.

On the next page we give an abstract of the various tenders sent in, as appended to the report.

Note.—The Electric Light Engineering Company make it a condition that they may be permitted to light private premises in the districts for which they tender. The Electric Light and Power Generator Company tender for No. 1 District only, and ask to supply lighting to private premises. Mr. James Fyfe, if permitted to light private premises, would make the charge for lighting the streets the same as the gas saved plus 20 per cent. This applies to both the Joel and Pilsen systems. The Hammond Electric Light and Power Supply Company will light all four districts for £3,000.

The following particulars refer to the kind of lamps to be used, mode of fixing same and conductors, &c. contained in the tenders for District No. 1:—

Mr. J. D. Cardew will use C. H. Long's patent lamps. The conductors will be of copper wire stranded together, properly insulated, and laid in cast-iron pipes beneath the footways and alongside the channels in the carriageways. The engine will be of 25 h.-p. semi-locomotive. The dynamo machines will be C. H. Long's patent, and placed in premises on the north side of Long-lane, near Hague-street.

The Electric Light Engineering Company will use A. A. Common's patent arc lamps, erected on the existing five-light columns, where available, elsewhere special columns to be erected. The conductors will be of copper wire, suspended from lamp to lamp, or fastened to points of houses, and crossing the roads either beneath the surface or at a height sufficient to clear the traffic. The engine will be 16 to 20 horse-power semi-portable.

The Electric Light and Power Generator Company will use Weston arc lamps, as now in use in Queen Victoria-street, fixed on special columns. The conductors will be of copper wire, properly insulated and laid in wooden troughs and iron pipes beneath the surface of streets. The engine will be 20 to 25 horse-power, and will drive four Weston dynamo machines, a smaller engine being kept in reserve. The station will be in a vault under the Central Meat Market.

Mr. A. L. Fyfe gives no description of the lamp he proposes to use, but will utilise the existing gas columns where

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Name of contractor tendering.	To light for 12 months, from sunset to sunrise. 1			Provide, fix, &c., and take away machinery at expiration of contract. 2			Total cost of 12 months' trial. 3			No. of Lamps. 4			No. of gas lamps not lighted when electric lamps are lighted. 5			Estimated cost of present gas lighting. 6		
	Districts.			Districts.			Districts.			Districts.			Districts.			Districts.		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
	£	£	£	£	£	£	£	£	£							£	£	£
G. D. Cardew ....A	498	410	380	3392	3860	3105	3890	4270	3485	29	25	27	115	86	82	551	363	341
Electric Light Engineering Company ....B	1510	1434	1570	1650	1450	1500	3160	2884	3070	32	29	30	122	85	79	—	—	—
Electric Light and Power Generator Company ...C	1620	—	—	4130	—	—	5750	—	—	36	—	—	119	—	—	—	—	—
A. L. Fyfe ....D	520*	395*	390*	3486*	3800*	3175*	4006*	4195*	3565*	27	24	26	113	84	80	—	—	—
James Fyfe (Pilsen System) ....E	1000	1074	1117	1852	1717	1942	2852	2791	3059	24	24	26	110	85	80	—	—	—
James Fyfe (Joel System)F	1117	1302	1400	2267	2282	2400	3384	3584	3800	80	80	80	110	85	80	—	—	—
Hammond and Co. ......G	840	690	870	1350	1800	1600	2190	2490	2470	28	23	29	125	85	79	—	—	—
Laing Electric Light and Power Company.........H	560	560	560	1790	1790	1910	2350	2350	2470	28	28	36	all	all	all	—	—	—

* Amended tender afterwards sent.

District No. 4.

The letters in the following table represent the contractors' names in the same order as they are given above, the columns being numbered as in the above table the better to identify them.

	1	2	3	4	5	6
	£	£	£			£
A	620	2986	3606	28	127	612 about
B	1850	1700	3550	30	136	—
C			No Tender.			
D	590	2900	3490	27	125	—
E	1139	2678	3817	33	139	—
F	1500	2850	4350	80	139	—
G	1200	2500	3700	40	137	—
H	720	2200	2920	36	all	—

practicable. The conductors, of which no description is given, will be placed underground, in cast iron pipes. No description of engine or dynamo is given. The station will be on the north side of Long-lane, near Hague-street.

Mr. James Fyfe in one tender proposes to use Pilsen arc lamps fixed on existing gas columns where available, or on new posts of similar pattern where required. The conductors will be of copper wire, insulated, and laid in cast iron pipes beneath the surface of the streets. The engine will be a 16 horse-power semi-portable, placed in a building at the Smithfield end of Giltspur-street.

Mr. James Fyfe in his second tender proposes to use Joel's semi-incandescent lamps fixed on existing gas columns. The wires to be laid as above. The engine to be a 30 horse-power semi-portable, fixed in same station as above.

The Hammond Electric Light and Power Supply Company propose to use Brush arc lamps, fixed on special columns 20ft. high. The conductors to be of copper wire, insulated, and laid in cast iron pipes beneath the surface of the streets. Semi-portable engines and Brush dynamo machines will be used. This company had not determined the site of their stations.

The Laing Electric Light and Power Company would use Laing arc lamps, fixed on special standards, and on existing gas columns where practicable. The conductors were not described, but would be laid underground on the Laing system. The engines were not described, but the dynamos would be on the Laing system. This company did not give the site of their station.

The particulars with reference to lamps, mode of laying conductors, &c., are the same for all four districts, the only difference being that the stations are different for each different district. We give the sites of these stations as mentioned by those tenderers who have fixed upon a station.

Thus, for District No. 2, Mr. Cardew's station would be No. 1, Swan-yard, Bishopsgate-street Without, Mr. A. L. Fyfe also taking this as his station. Mr. James Fyfe's station would be in White Hart-court, Bishopsgate-street Without.

For District No. 3, Messrs. Cardew's and A. L. Fyfe's station would be in Aldgate High-street, near Chequer-yard, and Mr. James Fyfe's in a building on the north side of Leadenhall-street, opposite Billiter-street.

For District No. 4, Messrs. Cardew's and A. L. Fyfe's station would be in Wheatsheaf-alley, near Fishmongers' Hall, and Mr. James Fyfe's in a warehouse in Swan-lane, Upper Thames-street.

CORRESPONDENCE.

THE INLAND TELEGRAPH SERVICE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: On behalf of the Telegraph Clerks' Association I thank you for the criticism you have deigned to award the sayings of our representatives.

Criticism is always useful—more especially so when coming from an organ so powerful as *The Electrician*, whose pungent opinions upon official matters are often suspected of being officially inspired—tending as it does to show us our own weak points, and, what is of equal importance (to us, at least), a knowledge of our opponents' strong ones.

As you so justly remark, the mere fact that the clerks have continued the agitation for twelve months after the promulgation of a scheme of revision, without considering expense or trouble, is alone sufficient proof that the scheme has failed to remedy the grievances acknowledged to have existed, either through its own imperfections, or through the "partial" character of its application.

That the Department has been able to stifle the agitation in the Central Office by means of indirect bribery and intimidation, thus enabling them to deal more arbitrarily with the rest of the service, is not, in my opinion, sufficient evidence to prove the scheme adequate. Before, however, making a definite statement upon that point, I think it would be advisable to briefly recapitulate what our exact grievances were in 1880, as set forth in our united petition of 31st January, 1881.

First.—Inadequate salaries, which, to a large extent, were due to the hindrance to promotion given by *classification*.

Second.—The mode of payment for overtime.

Third.—That no special payment was made for Sunday, Good Friday, and Christmas Day.

Fourth.—Insufficient annual leave of absence.

Fifth.—Inadequate subsistence allowance when employed away from home.

The question naturally follows, what has the scheme done to remove those grievances?

The second and fifth have, I admit, been to a large extent remedied, as also has the third, as far as regards Good Friday and Christmas Day; but, with respect to Sunday duty, we are on precisely the same footing as previously, Mr.

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Fawcett's estimated value of the concession to the entire telegraph staff being only £300, which plainly shows that the grievance still exists. The fourth complaint, which the Postmaster-General considered of sufficient importance to promise further consideration, and even to warrant him in suggesting a remedy, has not been redressed. The first and most important grievance of all alone remains to be dealt with. In the course of your editorial remarks you say :—" If they (the Association) object to any sort of classification these delegates should say so, nay, they should have said so before the old classification was succeeded by an amended one of the same order."

I am afraid, sir, you have given but little attention to our various " *tavern innuendoes*," which the London and provincial press has so largely published, or else, for the moment, they had passed from your mind. That is identically what we have been petitioning and praying for from the beginning. We must not, however, be misunderstood. There are classifications and classifications ! We are fully aware that some kind of classification is necessary to divide the higher branches from the general body, such, for instance, as the Playfair scheme, but it is the classification of the general body we object to and ask the abolition of. It must be admitted that it is a farce to see two men sitting side by side, performing in every respect identically the same duties and equally well, the one a first-class clerk with 40s. per week, the other a second-class with probably 23s. per week, and equal length of service. It must necessarily create a spirit of dissatisfaction in the mind of the second-class clerk, that is, if he thinks at all, which is intensified when he remembers that *death* or some such remote contingent is the only means of his obtaining the position to which he naturally aspires, and his abilites and length of service entitle him. What is required, and what we believe is necessary for the welfare of the service, is abolition of such classification, and the opportunity given to all to commence at the minimum and rise by periodical increments—somewhat larger than are now given—to a fair maximum. Let there be but one class for the general body of telegraphists.

With respect to our new grievance, the " unjust and partial " application of the scheme, what, sir, would you naturally understand by amalgamation—that the two or more bodies amalgamated were made *one*, treated exactly alike, and enjoying the same priviliges ? Is this the case with our amalgamation ? We are certainly tacked on to the postal branch, but what do we find is the result of the application of the amalgamating scheme ? That, whilst the whole service of the postal clerks has been allowed for when fixing their positions and pay, the service of the telegraph clerks in the old companies, and, in many cases years of the time they have passed in the actual service of the Post Office is altogether ignored, although the Act of 1868 distinctly states " that they should be entitled to count their years of continuous service with the telegraph companies as years passed in the service of the Crown." In fact, their pay and position under the scheme are regulated by the length of service they have performed at the particular office at which they were located when the scheme was applied. The result is that postal men with eight years are the seniors in pay and position of telegraph clerks with 16 years, and in many cases longer service, who should in all justice be treated with the same consideration. We also find that youths who have failed to pass as telegraph clerks, or who were employed as telegraph messengers and letter carriers, have been appointed as sorters, and are, under the scheme, in a higher position than those telegraph clerks who were previously their superior officers.

Is this, I would ask, a chimerical grievance ? Does it, as you state, affect only the few ? Or could it be remedied by strong local action ? No, emphatically, no ! It is a real, substantial, existing grievance, affecting not the few, but the many. Our twelve years' experience of postal officialism has taught us that, however much we may detest the course, because in our hearts we do detest it, nothing but combination of a united and healthy character can procure our claims the consideration they deserve. While such grievances as these are permitted to remain unredresssed, so long, I am afraid, will the telegraph clerks continue to agitate, and lay their complaints before the public, who are their real employers, even as they are of those permanent officials whose past apathy to our just claims has brought about the present unhappy state of affairs, and driven so many of the best clerks to seek other employment.

I think, sir, I have fully proved my points that the scheme is inadequate, that it has been applied " partially and unjustly," and that our grievances are not mere fancies. Thanking you for supporting our appeal for a Select Committee, trusting soon to see it at work, and agitation in our branch no longer compulsory.—Yours, &c.,

A MEMBER OF THE CONFERENCE.

ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION (LIMITED).

TO THE EDITOR OF THE ELECTRICIAN.

SIR : The success of an enterprise ordinarily shuts the mouths of objectors against irregularities. But in the case of this corporation its unexampled success aggravates the injustice of which I have to complain. The prospectus issued in December, 1880, states the capital as £800,000 in 80,000 shares of £10 each, of which the first issue was £400,000, and the following is a copy of Section 12 of that prospectus : " Applications for shares should be made in the form accompanying this prospectus, £1 to be paid on application, and £3 on allotment. *It is not at present intended to call up any further capital*, and for any call one month's notice will be given," &c. When in January last I received the report and accounts of the first year's proceedings I discovered that of the 40,000 shares (of which 10,000 went to the vendor company) some favoured shareholders had been permitted to pay up the additional £6, making £10 per share on 3,001 shares, and I thereupon applied for permission (which was refused) to pay up a like amount on the shares allotted to me. A meeting having been convened for the 18th inst. for the purpose of passing the following resolution :—" The directors may from time to time, of their own authority, pay to the members *in proportion to the amounts paid up*, or credited as paid up, on the shares held by them respectively, such bonus and such interim dividends as in the judgment of the directors the position of the corporation justifies," you will, I hope, allow me through your valuable paper to bring under the notice of my fellow-sufferers, the holders of the 26,999 shares on which only £4 has been allowed to be paid, the injustice done to us if these favoured shareholders are to receive in respect of their additional £6 per share the very large profits (capital as well as income) realised by the corporation *in the same proportion* as we do upon the £4 per share, to the payment of which we have been restricted.—

Yours, &c., AN ORIGINAL ALLOTTEE.

July 10, 1882.

DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : Not being very conversant with electrical conditions, I shall feel greatly obliged if you will explain the following matter through your columns :—I have two small continuous current dynamos (each working one arc lamp) in use. They are both bolted to the same wrought iron bed plates, but carefully insulated from actual contact by sheet asbestos. These machines run in opposite directions, and one lamp (either one), frequently goes out, or perhaps nearly so, whereupon the other immediately brightens up, as though it received the current which failed to pass through the first. What I wished to know was—if the presence of the wrought iron plate brought this about in any way ? or, was the fact due to the machines being run in opposite disections ? or, would it be possible under the circumstances for one machine to act the part of an exciter to the other ?—Yours, &c.,

WONDERER.

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WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: To this question I have failed to see given any reliable answer, and my suggestion may be equally unsatisfactory. However, when endeavouring to solve a law of Nature, my experience tells me to inquire into and search it out from the simplest form known to us in daily life.

We know electricity is produced to our senses in one of two ways—either mechanical, *i.e.*, by friction, or chemical, *i.e.*, by the conversion of some sorts of matter into other sorts.

I submit that, as electricity is common to all things, its mechanical production has precedence of the chemical, and that the electricity in things partakes of the principle of "storage."

We only know things by what they do. Bearings heat by frictional contact to a very high and even visible temperature.

Two rapidly revolving discs, not in contact, but so close together as to admit only of an air space between them, develop electricity quickly and in a most powerful form from the rubbing together of the molecules of air between the discs.

Let me now observe that the world rolls round itself at the rate of 1,000 miles an hour, and travels round the sun at the rate of 6,500 miles an hour, the atmosphere travelling with it.

Is it not a fact that our planetary system works from east to west by the south, and that our world revolves from west to east? Surely with such motion there must be a "slip" producing friction and electricity.

If there is a "slip," then electricity would be an effect of Nature's laws of friction; but whether that friction produces it *de novo*, or stimulates it into action from a latent state, I am not prepared to say, but prefer the latter theory.

If it is a "primary," there is no use in asking "What is electricity?" but we may ask—Where is its source?—Yours, &c., J. D. SHAKESPEAR.

July 12, 1882.

INDIAN AND ORIENTAL ELECTRICAL STORAGE AND WORKS COMPANY (LIMITED).

A general meeting of the members of this Company was held at the Cannon-street Hotel on the 11th inst., under the presidency of Mr. Ernest Noel, M.P.

The SECRETARY (Mr. H. Cleland Heywood) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen—You are are aware that by the Act of Parliament a company must needs meet within four months of its allotment, and, therefore, this statutory meeting has been called. In an ordinary way I think it is wiser to say next to nothing on such occasions as these, and merely announce that the allotment of the shares was made. On that, in this case, we have the pleasure of telling you that all the shares were allotted, and that the applications considerably exceeded the amount required to be allotted. But what I really wish to say to you to-day is regarding something which has happened since the allotment of shares—something that I believe will be very much to the advantage of this Company. You have probably heard, or may have seen in the newspapers, that an arrangement has been made by the Electrical Power Storage Company with the Faure Company, and it is concerning this that I have to say a few words. In our prospectus we put forward what we considered a very important question in buying patents—that we had a guarantee from the vendors that our patents would stand. The only real fear we had was as regards any possible infringement by our patents of the Faure accumulator, and, therefore, we demanded from the Storage Company, who were the vendors, a guarantee that our patents should stand. We had no doubt as to the superiority of our batteries over those of the Faure accumulator, but we had a fear that those batteries—the Sellon-Volckmar batteries—might possibly be some infringement. The Storage Company were well advised that there was no infringement, but still there might be, and we made it a *sine quâ non* that we should have a guarantee. The scientific opinions we had regarding our own batteries were very satisfactory, especially that of Mr. Cromwell Varley, a name well known in the electrical world, who, to use his own words, said, "It is a wonderful battery;" and I believe that the world will find out that the Sellon-Volckmar is a wonderful battery. There was, however, a rival in the field—the Faure accumulator. We had no guarantee as to that—as to our having no rivals. All that the vendors guaranteed was that the patents were valid. Shortly after the allotment we heard that litigation was threatened between the Faure Company and the Electrical Storage Company. After a time we further heard that these two companies preferred peace to war. I am not going into the question as to the arrangement made between these two companies. That is no affair of ours. Whether it was wise or unwise is no matter to us. What were the details of the arrangement is really immaterial to us. All that we have to know is that an arrangement was made between these two companies that they should work together; but there was a question which was very important to us. Did this arrangement between the two companies have any effect on our Company? Now, it came to pass that the Storage Company which had guaranteed the validity of our patents, had now become the possessors of the Faure patents, of the patent rights of the Faure accumulator as regarded practically the whole world; but, at all events, I only speak of that part which belongs to us, of India and the East. This being the case we felt it incumbent on us to enter into negotiations with what I may call the parent company. Those negotiations were chiefly carried on through Mr. Sellon, the gentleman whose name stands at the head of our patents - the Sellon-Volckmar battery—and I have to assure you that such negotiations were carried on in a manner of great fairness and uprightness. Any one who knows Mr. Sellon knows that in dealing with him you are dealing with a man not only of remarkable cleverness, not only a great inventor, but a gentleman of remarkably upright and straightforward character; and, therefore, in dealing with him I felt that I was secure, in dealing with one who would treat this Company fairly. I may say more—that though these negotiations were carried on chiefly through Mr. Sellon himself, the Electrical Storage Company met our Company in an extremely honourable, and more than conciliatory manner. They met us in a way which I can only characterise as wishing to treat us with the favour with which a father might treat his eldest son. They had taken great interest in the formation of this Company, and they had a full belief in this Company, as I will show you in a few moments, and, therefore, were determined, to a certain extent, whatever might have been their strict rights, to pass over to this Company the whole of the patent rights of the Faure Accumulator as regards India and our other territories. The terms for which this important concession was given—for I will explain how it was an important concession in a moment—were simply these:—As regards the whole amount we were to pay to the Electoral Storage Company, that remained the same. The only difference that they demanded of us was a variation as to the mode in which the payment was to be made. In the first place, you are aware, as you could see in our prospectus, that we were to pay £25,000 by way of royalty. This royalty might have been spread over some time—it might possibly, if we were not very successful, have been spread over some years. We have, however, now made an arrangement with them that that £25,000 for royalty shall be paid within twelve months by instalments. There was another arrangement which you may recollect was in our prospectus—that we were to pay £50,000 in shares, with the option of paying it in cash. Most vendors are anxious that they should be paid in cash. I have very rarely heard of a vendor company that was desirous, specially desirous, of retaining the shares or having the shares of any subsidiary company given to them: but as I said just now, the Storage Company think well of us. I think they have reason to, but at all events they do think well of us, and they were desirous that we should have part of the option, as regards 5,000 of these shares, or £25,000, taken away—that we should hand over to them that £25,000 in shares without our having the option of paying them in cash. We thought that this was a very fair concession to make, and therefore as regards the option of half the shares we were to transfer to them, we have given it over to them, and they will certainly now be given 5,000 shares, and the remaining £25,000 will be given in shares or in cash, as we may elect. Beyond that we have paid nothing for what I shall now, in a very few words, try to point out are the advantages we have gained from the concessions we have obtained. I may say at once that these concessions would not have been granted to a company differently situated from ourselves. It was only in consideration of the special guarantee they had given us, and the consideration that we had so early entered into the field in these negotiations, that the Storage Company felt themselves justified in making such very easy terms with us in this manner. But, perhaps, some one will say, what is the advantage of the Faure patents to us, as you say yours are the better of the two? I do say, and I strongly affirm it, and I believe that the world will know it ere long, that the Sellon-Volckmar as secondary batteries are very much better and far stronger, and therefore are of far more commercial importance than the Faure; but in saying that I do not want to detract for one moment from the value of the Faure accumulator, and the Faure accumulator has some advantages which the Sellon-Volckmar has not, inasmuch as the Faure accumulator is known, I may say, almost throughout the world, whereas, however much it may be known hereafter, the Sellon-Volckmar battery is at the present moment not known, though we hope it very soon will be. Therefore, there is that great advantage—that we are now possessors of a patent so well known and so highly thought of as the Faure accumulator. There is also another great advantage—an advantage that is not to be lightly estimated by us, and that is that we get rid of what at present appears, and I believe I may say appears almost positively—the only litigation we could have entered into as regards any one attacking us. We may eventually have to enter into litigation to prevent our patents from being pirated, but as regards any attack on us, by having become the possessors of the patent rights of the Faure accumulator we have got rid of all litigation. There is something still further than that. We have also got rid in India of what would, at all events for a time, have been a rival. We have now possession of the sole accumulators that are commercially of value. I am not prepared to say, in the present state of electrical science, what advances may be made. I am not prepared to say that there may not be in future some better mode of storing electricity than by our battery. All I can say is this—that at present there is none known, and, as far as we can see, there is not one likely to be discovered for some time to come that will not be an infringement of our patents. For some time, therefore, we certainly have a monopoly of what are, perhaps, the most important rights that there can be in the present condition of electrical knowledge. There is something else. In addition to all this—and I think this alone would show us that we have obtained in these patents something of real value to our Company—it enables us to manufacture our batteries at somewhat less cost. I cannot go into the details of that, and you must merely take it from me - but I have had it on good authority—that the manufacture of our Sellon-Volckmar batteries, which are the ones which we shall continue to hold and use, may be somewhat improved, but will certainly be somewhat cheapened in their production, and that is so much clear profit to us in the future. I cannot say what may be the future of electrical science. I cannot say what may be the future of either the use of electricity, or the means of storing electricity, but I can say this, and I think we may congratulate ourselves on it, that already it has been proved that the storage of electricity is a great advance in the progress of mankind in

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enabling us to lay hold of some of the powers of Nature which up to this time we had not been able to lay hold of. As just one illustration I may say that we are at this moment engaged in negotiations—I may say negotiations are very nearly completed, and I trust to get a telegram very soon to say that they are completed—by which we shall be the possessors of the natural force of a waterfall in one of our territories, and the horse-power in the waterfall will be at once transmuted into two things. One will be the lighting of a town, which will be done by a company that is ready to give us orders for batteries for that purpose; and the other will be for motor power in carrying out some important Government works in its neighbourhood. This is only just an illustration of what is in store for us. Our field is great. I believe there is no company except the parent one that will rank higher than our own as to the territories we possess. I believe there is an opening in India both for electric lighting and the use of electricity as a motor power that is not surpassed in any other country in the world. Therefore I think we may look forward hopefully, knowing the difficulties we have to encounter—difficulties from the inexperience of our electrical engineers, difficulties of all sorts that must be encountered when a new power, as it were, is brought under the dominion of man, and is being pressed as a commercial undertaking. Taking the most sober views of all those difficulties, which we are quite prepared to encounter, I think I may say with confidence that there is a very bright future for this Company. There was just one point I omitted to allude to in speaking of the terms regarding our becoming the possessors of the patent rights of Mr. Faure, which was this: that, of course, the Electrical Storage Company is no longer required to give us a guarantee. We forego the guarantee they then gave us, as the Board consider that we have secured something far better than a guarantee, by securing those patent rights which alone could or might have endangered our patents. I do not think I have any other question to touch on to-day. I hope that next year, if I have the honour of addressing you again, it will not be to say what we hope to do or may do, but what we have done, and I look forward with very considerable hope to be able to say something that will be very gratifying to all the shareholders of the Company. I will ask Lord Crawford, one of our directors, who is well known in the scientific world and also in connection with electricity, to say a word or two as regards the batteries themselves. It might be interesting to the shareholders if he would do that.

Lord Crawford and Balcarres: Mr. Chairman and Gentlemen—It would be very difficult to say anything on the subject of the batteries without actually going into a long scientific exposition of their method of construction and their uses, because the chairman has already laid before us in detail the uses of these batteries, and the methods how they can be used, without actually going into the practical mechanical differences between the Sellon-Volckmar battery and the Faure accumulator. I think, unless I were to do that, there would be very little for me to say. I am sure the chairman has gone most carefully into the whole matter. There is one thing perfectly self-evident to any one who studies electric lighting, or has anything to do with electricity, and that is that it is an absolute necessity that there should be the means of producing electricity at a certain given time, and of putting that electricity away or storing it till such a moment as you may desire to utilise it. Without some means of doing this, electric lighting is practically commercially impossible. I refer, in saying that, not to the lighting of docks or streets, but to the use of the electric light for domestic purposes, or for any place which could not be characterised as a large place. I do not think the science of electricity is sufficiently advanced yet to work the light in houses, in rooms, to have it under control—I am speaking of incandescent lighting—without having storage cells, by which you may put away your electricity till you require to use it. The question is, how best to put away the electricity, and there is no doubt that storage cells, or the Faure accumulator, is the only practical way of doing it. A few years ago the Faure accumulator made a great sensation throughout the world, but since then busy brains and clever men have been at work, and Mr. Sellon has produced a battery which the Company say is superior to the Faure. I do not wish to go into their merits, as we are perfectly friendly, but if the Sellon battery was an improvement over the Faure accumulator Mr. Faure was the only rival that Mr. Sellon had in the field when the arrangement was made between them. There have been batteries called storage batteries by numbers. You can make one by merely decomposing water and then let it recompose. That is a storage battery, as it is a question of force laid by, but it has no great energy in it, and it is costly to produce. The question of these batteries, or, rather, of the position of the Company, is that we hold now the Sellon battery, which we may call No. 1, and also the Faure accumulator, which we may call No. 1*. They are both in the front rank, and now being amalgamated I think there is no reason to fear any danger of being improved on. The great difficulty of improving on the Sellon battery is that, so far as I remember, it will reproduce about 80 to 90 per cent. of the amount of energy which is placed into it. Therefore, any person who wishes to improve it has only 10 to 20 per cent. to improve on, and that is very small indeed when you come to think of the difficulty that has been met with in producing a battery that actually does reproduce such a percentage. I have also been informed that the Sellon battery has not been asked to perform all it can do. I do not think I need detain the meeting further.

The Chairman: If any shareholder would like to ask any question I should be most happy to answer it. It is not, however, like the next time, when there may be many questions to be asked as to our working; for at present there is no working, though I hope that the first batteries will be delivered this week, and that they will be tested this week or at the beginning of next week. We have purchasers for those batteries, and for as many as we are likely to obtain for the next few months, and before those few months are over I have no doubt that we shall have many more purchasers. I am very glad at the point having being brought out by Lord Crawford, that incandescent lighting for domestic purposes is simply an impossibility without storage. I am connected with a company that is anxious to produce incandescent lighting, and that company has stopped its incandescent lighting till it could obtain these storage batteries, because it felt that it was so unsatisfactory to have any lighting that you could not use just as you use gas—to use as little or as much as you like—that you might feel that you had your supply at hand, and that you had no fear of a sudden extinction of the light, and of the house being left in the dark by the failure of your engine or anything else. It must, in fact, be self-evident, I think, to any one who thinks about it, that storage is absolutely essential for the lighting of houses.

Mr. Boyd observed that Lord Crawford had stated what was the loss of power in the Sellon-Volckmar battery, and he would, perhaps, say the loss in the Faure accumulator.

The Chairman: I should not like to give an opinion on that subject—as to the Faure accumulator. Our own opinion is that the Sellon battery is better, and, great as was the advance made by the Faure battery, we believe that the Sellon is an advance on that. As we have not yet had the Faure batteries to work with, I should not like to give any opinion on that subject at all. I have often conversed with scientific men on that subject, I have seen the Faure battery at work at Paris, but I should feel that it would not be just to those who think highly of the Faure accumulator to give an opinion on that subject. We can only speak of what we are possessed of, because our scientific experts have already tested them. I dare say we shall be able next year to give you that information more completely. I think I may now declare the meeting at an end. I hope to have the pleasure of meeting you next year, when we trust to have some very good results from our working in our Indian Empire.

A vote of thanks to the chairman was then proposed, seconded, and carried unanimously, and in reply

The Chairman said: I beg to thank you, gentlemen. It has been a very pleasant meeting, and I hope it always will be with the Indian and Oriental Storage Company.

The meeting then separated.

THE EASTERN TELEGRAPH COMPANY (LIMITED).

The twentieth half-yearly ordinary general meeting of this Company was held on Thursday, the 13th inst., at the Terminus Hotel, Cannon-street, under the presidency of John Pender, Esq., M.P.

The Chairman opened the proceedings by formally requesting the secretary to read the notice convening the meeting.

The Secretary (Mr. George Draper) accordingly read the notice, and subsequently the minutes of the 19th half-yearly meeting held on the 2nd February last.

The Chairman: Gentlemen—Is it your pleasure that these minutes be signed?

The meeting having signified their assent, the chairman signed the minutes.

The Chairman: Gentlemen—I presume you will take the report as read. You have had it in your hands for some days. As usual, I shall refer to some items in the report so that you may have a more accurate idea of the working of our system during the last six months. The revenue for the six months ending the 31st March, 1882, amounted to £321,811, against £302,159 in the corresponding period of last year, being an increase of £19,652. The increase of traffic is attributable to the increased receipts generally, and I may also say to the traffic which is now being carried on from the South African cables. The Indo-European line was interrupted during November and December, and again for a fortnight in the middle of January. The Great Northern Company's route to China was simultaneously interrupted in November and January, so that during a month and a half the state of the traffic between India, China, Australia, the far East, and Europe, and America was carried by the cables of the Eastern Company. The ordinary expenses of the Company were £75,141, against £67,754 in the corresponding period of last year, or an increase of £7,387. This increase is accounted for as follows:—The sum of £1,000 has been written off the cost of the Lipari and Messina cables. This is capital expenditure, but in accordance with the report of July, 1881, the directors will write off gradually the whole cost to revenue, the total amount being about £5,000. In other words, we are taking out of revenue an amount of money to pay for this Lipari cable, from which we receive an annual subsidy, so that in a very short period of time we shall have wiped out that amount instead of adding it to capital. In the corresponding period last year was a charge for the staff endowment assurance for four months only, though this half year we have a six months' charge, consequently the increase is in proportion. There is also £216 for expenses in connection with patents, and £421 for expenses of the Paris and Crystal Palace Electrical Exhibitions, at which it was considered that our system should be fairly represented, and any one who visited those exhibitions would see that the displays were not done in a very expensive way, and that after all our Submarine Electrical Exhibition was, perhaps, the most important of all. As to the salaries and wages, travelling expenses, land lines, stationery, and printing, full details can be given. We carry to reserve (and I am very much pleased to say it) £75,000 against £70,000 last year, and we pay a dividend of 5¼ per cent. Had it not been for the large expenditure in repairs to cables the amount we could have put to reserve would have been considerably increased. The reserve fund now amounts to £490,817. Repairs to cables, I am sorry to say, come to a large amount—£40,269 against £29,942, or an increase of £10,327. Well, this is a very large sum, and I only hope it will not continue as large. In all these repairs which we are making to our cables we are putting in new portions, that being all done at the cost of revenue. We are, therefore, maintaining our system in a thoroughly efficient state. The particulars of the ships' movements will be seen in Abstract C of the accounts. The expenses at the stations show an increase of £5,382. One item of increase is salaries and wages, which are £1,617 more than last year. This is owing to increases granted to the principal officers and clerks of the Company in accordance with a resolution of the board that, directly the yearly traffic reached half a million, an increase should be granted to several of the staff who had been in the service of the Company since its incorporation. The travelling expenses were heavy, in consequence of a large number of the staff being entitled to leave of absence after a period of five or seven years of foreign service. I am quite sure the gentlemen I am addressing will agree that the principle we have laid down of allowing our young men after five or seven years' service in India leave of absence to return home is a very good course. They go back to

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India and other parts with renewed health and renewed vigour. It is a peculiarly monotonous life that they lead, and it is very desirable that they should get out of the groove they are apt to get into in a period extending over five or seven years' foreign service, and we consider that in the interest of the young men themselves, and more immediately in the interests of the Company, that these changes should take place. The next important increase is the expenses of stationery and printing, which is caused through a larger supply being required for our more important stations, owing to the very considerable increase of traffic. As to the working expenses at stations, the salaries and wages in 1882 were £31,982, against £30,365 in 1881. The travelling expenses were £1,955, against £1,105. There are a number of other details that I have here, but these sum up the whole thing. Our expenses at stations were £53,474 in 1882 against £48,092 in 1881, and there was a net increase of £5,382. I have now given you a pretty fair idea of the expenditure, and I have some more figures before me. I am quite ready to answer any questions as to details, but the result of the general expenses in London is an increase of something like £477 in certain items, and with a decrease in other items of £816, so that the net increase is £166, which is not very much, looking to the very considerable increase of labour that has been necessary, owing to the additional operators required in consequence of the increased traffic. Having given you these details I think I may now make some general remarks which will interest the shareholders. The first is as to the state of our cables. Well, during last year we have had more than the ordinary amount of repairs, as I have just indicated, more particularly in the Bay of Biscay. We have had two steamers at work there, and it has been, perhaps, the most prolonged repair we have yet entered upon; but reading, as I have done, morning after morning that the ships were obliged to run into harbour on account of the weather, I infer that the continuous rough weather is the great cause of the delay in carrying out those repairs. We received a communication only this morning from the captain of the "John Pender," which is very satisfactory so far as it goes, but it would have been much more satisfactory had he announced that the cable was repaired. However, he states that they are in harbour from stress of weather. He goes on to say that he hopes to grapple the cable in 2,500 fathoms of water over a splendid bottom, and that "weather and sea permitting, I have every hope of being able to complete it, as the cable is apparently in excellent condition." I may tell you that last week, as Sir James Anderson reminds me, they had the cable up on board the vessel from 2,150 fathoms deep. They had it on board, but the ship lurched, and the cable went over. That is an accident that will occur, but this shows you that we can certainly grapple the cable, and, therefore, a thing is not lost if you know how to find it [laughter]. I hope any morning now, as we are looking for finer weather (and we have had very little fine weather yet in these latitudes), to have the cable repaired. The next remark I have to make is as to the state of the cables in the Red Sea. We had two faults in the Bombay cable. We have repaired one of these faults, but the other we have been obliged to delay owing to the monsoon coming on. It so happened, however, that at that moment the state of affairs in Egypt necessitated our bringing our steamer, the "Chiltern," which we generally keep in the Red Sea, to Alexandria, and I think that those who are watching the state of affairs in Egypt will observe that the "Chiltern" has done a very great deal of good work [hear, hear]. I think we may congratulate ourselves on the fact that without the "Chiltern" you would not have had the same amount of news, and that the Government would not have been able to guide and direct affairs as they have done, had it not been for the Eastern Telegraph Company's system. I may say that we have placed the "Chiltern" under the orders of Sir Michael Seymour, the British Admiral.

Sir James Anderson: Sir Beauchamp Seymour.

The Chairman: Sir Beauchamp. Sir Michael Seymour is a very old admiral, and Sir Beauchamp is likely to prove that he carries on the good old name with honour and credit [applause]. The "Chiltern," I may mention, is now at Alexandria, and is doing good work, but I am sorry to say that the state of things at Alexandria has interrupted our system across the isthmus. Two days ago our system was interrupted, but you need not be alarmed so much about that, because, through the foresight of your directors, we entered into arrangements some few years ago with the Indo-European Company for a joint-purse arrangement, and that some more arrangements will carry us with our present returns, I hope, far beyond the time that will be necessary for us to re-establish our connection with the East. I hope, also, that there is no crisis of this kind that does not make men think, and I believe that the result of this crisis will be in all probability to give us increased communication with our connections in the East. I have referred to the Lipari cable. It is working most satisfactorily. It is a small thing, but it is satisfactory so far, that the Government of Italy are satisfied, and we are satisfied with the results we receive from it, and I will just remind you that we are not going to burden capital with it, but that we shall pay it from revenue. There is another important point to which I desire to draw your attention, and that is the Trieste-Corfu cable. At the last meeting, when I had the honour of addressing you, I told you that there had been many attempts by those whose business it is to obtain concessions, and get something out of these telegraph concessions, to get a concession from Austria to connect Egypt with her territory. They again invited tenders, and some of our friends with whom we are on good relations obtained that concession, and we have made arrangements, which will be brought before you by resolution, to secure that and incorporate it in our system. I may say to you that it is very important to us, looking at the great network of telegraphy we have got in the Mediterranean and the Levant, that we should hold any new work of this kind in our own hands. I think I referred to this on a previous occasion. The word "monopoly" is not a pleasant word, but I always meet such a remark by this statement—that it would be most difficult in these waters, frequently in confined parts, if competitors were to come there. It would be most difficult to maintain our cables in that case. If one of them broke we might, in seeking to repair it, pick up the cable of our neighbour, and there might be great difficulties through that. I think you will all agree that the dividend we pay now is not large enough for people to say that we are a monopoly. I say the dividends that we are paying, though they are paid steadily, are not such as any man can complain of or insist on competition being invoked to reduce them. At the extraordinary meeting which has been called to take place after this meeting, a resolution will be put to you which I hope you will approve of, enabling us to secure for the Company the Trieste-Corfu Egyptian cable. There is another concession to which I would wish to draw your attention, which has sprung up since I last addressed you—that is, the Tripoli concession. One of the first cables laid was that from Malta to Tripoli. That was a great many years ago. It was laid very much on its own merits—in other words, that a certain traffic was likely to be obtained so as to secure a fair return on the outlay. That cable broke and was abandoned, and in those days the Company was not rich enough to restore it. Time has past on, and I think when I give you one or two figures they will show you that we are justified in looking after this Malta-Tripoli concession. The exports in 1868 from Tripoli were £105,080, while in 1878 they were £477,034. The imports in 1868 were £83,325, and in 1878 they were £358,220. Now let us take the shipping. The arrivals in 1868 were 262, and in 1878 they were 858, the tonnage being in 1868 21,805 tons, and in 1878 105,272 tons; while the departures in 1868 were 260, and in 1878 824, the tonnage in 1868 being 21,919 tons, and in 1878 149,331 tons. Now, gentlemen, there is no greater index of the prosperity of the place, which I think is most remarkable, and one which certainly satisfied us, that, looking at the trade, which is young, we are likely to receive a very good return on the outlay. Our intention was to recover the cable—part of the shore end—but we have been very fortunate in securing from the Porte a renewed concession, giving the Malta and Tripoli line entirely into our own hands. It is a very important concession, and one, I think, that will give us very good results. A resolution will be put at the special meeting on the subject, and I hope that you will approve of it. As I foreshadowed last year, there is a most important question concerning us which I am now going to bring before you. It relates to the finances of the Company. Our debentures now amount to £882,000, partly bearing 6 per cent. and partly 5 per cent. interest. We think that our property has now taken such a position in the market that it has now become a security such as no one believed in ten years ago. We are, therefore, vain enough to suppose that we shall be able to float debenture stock at 4 per cent., so as to enable us to pay off the whole of our present debentures as they fall due. A special resolution will also be brought before you to confirm that. If we can effect the exchange, and can, on a 4 per cent. outlay, pay for these works which we are going to ask you to sanction to-day, we believe we shall have done a very good business, which I believe will be thoroughly satisfactory to the whole body of the shareholders. When we talk of these debentures you must not suppose that this is altogether additional. It is with a view to take, I hope, a higher financial position in the security market—a position, I think, we are fairly entitled to. I may say now, also, because I think it is right to foreshadow a little of what the policy and plans of your board are—if you read the speech I made to you six months ago—which I myself read this morning—you will find that I foreshadowed something of what I was going to bring before you as to these debentures, but we have other schemes to consider, which we may bring before you later. This, however, I wish you well to understand—that in these days of progress, telegraphy must be more or less prepared. Telegraphy used to follow, I believe; it must now lead; and, as I have said just now, our Indian and Colonial Empires are largely increasing, and demand that telegraphy should increase proportionately. I only wish you to understand that we are not going to let them wait for telegraphy, but that we shall anticipate their wants, and probably I shall shortly bring this matter before you, which I hope you will approve of. With these remarks I beg to move the following resolution:—"That the printed report and accounts of the directors to 31st March, 1882, submitted to this meeting, be and they are hereby received and adopted. That a dividend on the preference shares of the Company to the 30th June, 1882, at the rate of 6 per cent. per annum be paid, less income-tax, and that, in accordance with the directors' recommendation a dividend be and is now declared of 2s. 6d. per share, with a bonus of 1s. per share, both free of income-tax, on the ordinary shares of the Company, making, with previous payments by way of dividend on account, a total payment of 5½ per cent. on those shares for the year ending 31st March, 1882."

The Marquis of Tweeddale: I beg to second that resolution.

The Chairman: Gentlemen—I, of course, desire to hear any observations that you may wish to make on the general remarks I have made; but, as regards the resolutions which are to be proposed at the special meeting, we desire that they should be treated separately. The same remark will also apply to the financial question which I have brought to your notice; probably, therefore, you will defer any remarks you have to make on the Trieste and Tripoli cables till we pass the general report. Has any gentleman any remark to make on the report? Now, if so, I shall be very glad to hear him.

Mr. Stokes: Mr. Chairman and Gentlemen—We have had a very favourable report, and I think that our affairs are going on most satisfactorily. My object in rising to-day, however, is to inquire what the ultimate amount of the reserve fund is to be. When it amounts to a certain sum I suppose we shall get a certain increased dividend, and I should be glad if you would say what you consider is a reasonable sum. It now approaches half a million, and I suppose if you got it up to a million you would consider that sufficient.

Mr. Brixon: I may inform the meeting that I have just returned from the East. I have visited many of the Company's stations, and for good order, management, and respectability I never saw anything better. They were not prepared for my visit, but nothing could be better than the regularity with which our affairs are conducted. Many of the stations you have are by no means paradises, and anything that could make the position of the staff more pleasant will be acknowledged by them with gratitude. I may add, as regards the general management of the concern, that for such an undertaking it surprises me. Perhaps in my position it is hardly for me to say what I think, but I must say this, that the management of the board throughout is highly thought of by most commercial men, and is greatly esteemed by the general public wherever I have been.

Mr. Nicholson: I think I may make one remark, and that is that what is really in all our minds at the present moment is the state of Egypt. I think, if it will not be asking you too much, I shall carry the meeting with me if I ask you to be good enough to give us such information as you can as to events there. It is well known in the City of London that the Eastern Telegraph Company have done everything to give all news as fast

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as they have received it. I think the position the Eastern Telegraph Company will take up after this crisis will show that our board, our managing director, and the whole of the staff have had but one idea in view, the interests of Englishmen and the country at large. I don't like quoting from newspapers as a rule, but these few lines in a paper of this morning I would ask permission to read:—"It is to the Eastern Telegraph Company, as the proprietors of the sole lines of cable communication with Egypt, that the British Government and public are indebted for the almost unrivalled facilities enjoyed for practically instantaneous transmission of news from Alexandria. Tested by this standard, Mr. John Pender, M.P., the chairman, Sir James Anderson, the managing director, and Mr. Ansell, the traffic superintendent, are entitled to rank among the benefactors of the community. Even before the existing crisis the Eastern Company had earned a substantial claim to the confidence of the mercantile community by the excellence of its general arrangements, the regular and efficient working of its network of lines, and the punctuality and accuracy of its despatch of messages." It then goes on to say: "Of the unvarying attention and courtesy shown by the officials of the line amid these trying circumstances it is impossible to speak too strongly, and ere things return to their normal state it is only fair that such claims to public gratitude should be emphatically acknowledged." I feel confident that this meeting conveys its sincere thanks to our directors and to the managing director for all they have done for us on this occasion.

Mr. HIRST: One gentleman who spoke alluded to the reserve fund. I may congratulate the Company upon the fact that we have at this time nearly half-a-million at the credit of the reserve fund, but at the same time I do not pretend that that is so large a reserve as we should aim at obtaining. To give security to such an institution as this, it is necessary that we should have something considerable to fall back upon. Our capital is £4,500,000, that being the amount of our capital, half-a-million can scarcely be considered a very heavy amount for the reserve fund. At all events, I should like to see a greater accumulation till we should be in such a safe position that nothing would interfere with our moderate dividend in time to come. In a Company of this kind if you have not something to fall back upon an accident may occur that may be very prejudicial, but at present, while we can keep up our reserve fund, and have the good management which has been spoken of, we may feel that our property is safe and secure, and we may look on it as almost as safe as the public funds. We are getting this half year a dividend at the rate of 5½ per cent. I hope that that dividend will continue, and if in the course of a year or so the prosperity of the Company increases—and it seems to be going on very prosperously—it may advance by a half per cent. That, I think, would be very satisfactory indeed, and it is one of those circumstances that we may, I think, look forward to.

Mr. MONRO: One gentleman has spoken about the staff, and it is perhaps invidious where the staff are all good to make any special allusion. I think, however, that an expression from us conveying our sense of what the staff at Alexandria have lately done would meet with the approval of the shareholders generally, and with their leave I should like to move a resolution to that effect. Shortly after the outbreak at Alexandria I received a letter from one of the staff, and I should like to read you this extract:—"Six of us left the quarters about three in the afternoon, and went for a row round the men-of-war, and returned about six, and were going to land, when we accidently met some officers of the ships, who warned us not to go on shore, so we were miraculously saved from being probably all killed. We went and stopped on board Her Majesty's ship 'Invincible,' where we were all well treated by the officers. We came ashore on Monday afternoon, and were escorted to the office by an escort of soldiers and two officers with fixed bayonets. The amount of work we are doing is something fearful. We all have to do double duties, besides taking our turns at sentry duty (two hours). We have blockaded the quarters, and intend to defend it as long as we can." The letter then goes on:—"One of our clerks (Rainier), with three outsiders, started to come down to advise us not to come ashore. The three outsiders were all killed on the way, and Rainier, by a wonderful miracle, escaped with severe scalp wounds on the head and a damaged nose. Our washerwoman, who had a fortnight's washing of ours, had her house broken into, and nearly everything stolen, so we are in the lurch." I cannot help thinking that some little expression on our part would encourage them, as they are in great danger. We ought to remember that in the army and navy men feel that they are acting a patriotic part and watched. [A voice: "They do their duty."] Yes, but they are observed; telegraph clerks are not observed in the same way, and they also do their duty with scarcely any notice at all. I hope the meeting will, therefore, give some expression of the satisfaction with which they have learnt the way in which the staff at Alexandria has done its duty during the late crisis. I would move a special resolution to the proprietors presently to that effect.

Mr. NEWTON: May I ask if the report is true that one of our principal officers at Alexandria was slaughtered in the atrocities of yesterday?

The CHAIRMAN: The first question I have to reply to is that of Mr. Stokes, who asked us what is to be the maximum of the reserve fund. Well, I think it is very difficult for me to give a direct answer, but if you will allow me I will answer it in my own particular way. I think it is most desirable, looking at our capital (with our ordinary share capital and our debentures together we have five millions and a half), that we should have a very considerably larger reserve fund than we have now. We have got a very handsome sum, it is true—nearly half a million, but then, when you name half a million, you must also name five and a half millions, and we have 16,000 miles of cables. Consequently, I think we ought to be satisfied with the comparatively moderate dividend we are now paying until we increase our reserve. It is a very handsome addition that we are making now—£75,000—but if you remember I stated a year ago that I hoped we should be able to put £100,000 a year to our reserve fund, because our system is now considerably increased, and I said that when we were able to add £100,000 a year to the reserve fund it would be a good thing for the shareholders afterwards to get some consideration. Let me, however, say one more word as to the increasing of the reserve fund. If you do not get the benefit in one way you get it in another, and all prudent men like to put by a little out of their earnings if the shares, generally, go up in the markets and you find you have added to the value of your property, though you have not got it strictly in dividends. You must remember that you cannot get it in both ways. If you had not a good reserve fund your property would not stand in the market at the price it stands at to-day, and that it is likely to stand at as our reserve fund increases. I hope that that explanation will be satisfactory to the general body of the shareholders, and you may rest assured that when we get to putting by £100,000 a year to our reserve fund, if any one rises and proposes that something additional should be given to the shareholders I shall be ready to join in the proposal. As regards Mr. Brixon's remarks on the staff I have occasionally in the autumn made a point of going and visiting our different stations as far as time would allow. As you are aware, we have two or three steamers, and it is well for our directors to see what is going on at the stations. It is not a very expensive affair, but it is extremely beneficial. The young men like to see it immensely. They like to see the chairman, the managing director, or any of the directors. Sir James Anderson has visited them occasionally, Lord Alfred Paget has gone there lately; and altogether such visits keep up an *esprit de corps* among our young men which we consider very beneficial. I was never more pleased than at what I was told by the late First Lord of the Admiralty. Mr. Smith went out for a cruise both as First Lord and also in his own yacht afterwards. He said to me, "Mr. Pender, I never was more proud of my country, or an institution connected with it, than on my visit to your offices in the East, and in the Levant." He added, "The young men are gentlemen. I saw the place as compared with other offices there, and it was clean—so tidy and so business-like. All the young fellows were at their work, and everything was going on like clockwork. I tell you that I then felt quite proud of being an Englishman when I saw the institution so well managed." I may now say something further. I was very pleased two days ago at what the First Lord of the Admiralty, Lord Northbrook, told me. Lord Northbrook is, perhaps, one of the first men of business—I will not say in the Cabinet—but in the country. He has the old blood of the Barings in him, and that is shown very prominently in the department. He said:—"I was uncommonly pleased at the cable having been picked up in two hours, re-establishing communication in the morning." We felt extremely proud at this being recognised by a man like Lord Northbrook. The remarks which Mr. Monro made I think I have pretty well answered. I am sorry to say that this morning we have a telegram that a young fellow—a Frenchman, all honour to him—stuck to the office to the very last moment. Our office at Alexandria was burnt down yesterday, and this poor fellow was murdered. It is very sad. While I pay a tribute to his memory for his great courage and devotion to his work, I think it reflects very much on the people who were guilty of such a barbarous deed. As to the other young man, I received a letter this morning. On the day of the massacre Mr. Rainier left the office and went down to warn some of his companions who were going out in a boat to see the Fleet. His object was to save them, if possible. He was almost murdered, and was treated in such a way that, to use his own words, through Providence he was saved; but the two or three who went with him were murdered. These are painful stories to tell, but it is one of those incidents of war that make war so terrible that none of us can even desire it in any way.

A SHAREHOLDER. May I ask the name of the young French gentleman who was murdered?

The CHAIRMAN: Ternant. He was a nephew of the manager of our department at Marseilles. I can only say to Mr. Munro that when our board meets we shall recognise in the way we ought to do the extraordinary devotion to their duties which our staff has shown in the present crisis. I may mention that one of our doctors from the "Chiltern" went on shore to the assistance of an Arab who was severally injured—his leg being broken. This gentleman, without thinking of himself, went and reset the Arab's leg amid cheers from all who saw the act. I mention this to show that we have a good class of men in our service in the East. Mr. Nicholson asks me to give an opinion about Egypt. I wish I could see the end of the present state of things. My own impression is (I give it simply as my own impression) that as out of evil good sometimes comes, I hope (and I trust it may not be a false hope) that the result of all this will be to secure a permanent highway to our Indian and Colonial Empires. To secure that remains with the Government—I only express my own opinion; but, under any circumstances, it will be our duty to see that we secure for India a permanent system of telegraphic communication. I cannot enter into politics here; I think it wise to act on the advice I give to all our young men in the East, and as far as the Company is concerned I know no politics.

Mr. NEWTON: Is the Canal open?

The CHAIRMAN: I have only this morning been at the Admiralty, and I hope that before a long period passes over our heads Port Said will be connected with our system. If our advice had been taken three weeks ago it would have been done now. However, our Government do not, through the routine of departmental system, act as decisively as I should like to act.

Mr. NEWTON: If you get connected with Port Said, what means have you to communicate with Suez?

The CHAIRMAN: That is also under consideration. Thank you for making the suggestion. I think I foreshadowed a little information on that subject, but we have other people to deal with in connection with that work. There is one thing I might say, as it applies to our business. Twelve months ago I suppose that Egypt was perhaps the most prosperous country in the world. The Controllers were receiving the money regularly, the Egyptian Fellaheen were enabled to labour without molestation, and to keep the result of their labours; in other words, they were altogether prosperous. We in this country were receiving our dividends, and every man—bankers, merchants, and all classes of people—believed that Egyptian Stock was about the best investment that could be made, and of course the rate of interest was a considerable temptation. We had, therefore, a large amount of our reserve fund in that stock. I believe myself to-day that if I held Egyptian stock I should not trouble my head about it. I belive long before six months are over, whatever happens, that the chances are that Egypt will pay her dividends. You cannot burn the land, or destroy the people. You may destroy a town, but you cannot wipe out the Nile, and Egypt is a country which will very shortly resume the position she held a year ago. I may be sanguine in that, and war will always cause uncertainty. Looking forward to possibilities, which have really become facts, we sold half of our holding in Egyptian Stock at 91⅜. To-day we could replace that amount at something like 10

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per cent. less, and before long we may replace it, but we shall fully consider that course first.

Lord ALFRED PAGET: One word in corroboration of what has been said about our staff and their efficiency. I have been out there in my own yacht, and at my own expense, and have visited every station in the East, except Salonica, and what I saw was extraordinary, more particularly the pluck shown. I went to a certain island, Chios, which you all heard of in connection with the earthquakes there. The whole place was in ruins, everyone had left the place. Our station was in ruins, but they had erected a kind of wooden hut, and I saw men working there. I asked them whether they were not afraid? They said "No, my lord, we are not now; we are used to it, and we will remain and do our duty."

The CHAIRMAN: I see that the feeling of the meeting is very properly in favour of this public meeting expressing its full sense of the conduct of our staff, and I will, if you will allow me, read a resolution which has just been drafted, and I will ask Mr. Monro to second it, if the meeting approve of that. The solicitor corrects me and reminds me that we had better first pass the resolution that has already been moved by myself and seconded by the Marquis of Tweeddale. Having put the resolution in the usual way he announced that it was carried unanimously. Continuing he said: The next resolution is this:—"That this meeting desires to record its thanks to the staff of the Company for their services during the past year, and to declare its high appreciation of the great labour and anxiety which the Company's officers in Egypt have recently undergone, and of the zealous and efficient manner in which they have performed their duties under most trying and difficult circumstances."

Mr. MONRO: I have great pleasure in seconding that.

The Chairman put the motion, which was carried unanimously.

The CHAIRMAN: That is the end of the business of the ordinary meeting, and now we will go to the special meeting. The first resolution I have to propose is as follows:—"That the board be and are hereby authorised to purchase and take over the concession from the Imperial and Royal Austrian Government, dated 19th August, 1881 (referred to in the directors' report, dated 3rd July, 1882), for the establishment of a submarine telegraph cable connecting Trieste and Corfu, and the cable recently laid in pursuance thereof, at a total cost not exceeding £67,000.

Sir JAMES ANDERSON: I beg to second that.

The CHAIRMAN: Has any gentleman any question to ask me on that? There being no reply, he put the motion, and declared it carried unanimously. Continuing, he said: The next resolution is as follows:—"That the meeting approves of the board's proposal to lay a new cable between Malta and Tripoli as mentioned in the directors' report, dated 3rd July, 1882." I would just say in regard to that that we have a certain amount of spare cable which we generally keep in reserve, and we shall utilise that cable in laying the Tripoli cable, so that the amount will be comparatively small, and at the same time, as I have shown you by figures, I expect the result will be very considerable from it.

Sir JAMES ANDERSON seconded the motion.

The CHAIRMAN put it, and it was carried unanimously. He then said: —I think it would be well that you should be perfectly informed of the next matter to come before you, and the solicitor will read the resolution.

The SOLICITOR (Mr. Birt): This, gentlemen, is the resolution as to the creation of debenture stock:—

(A) That the board of directors be, and are hereby authorised from time to time to create and issue mortgage debenture stock of the Company to an amount not exceeding one-third of the share capital of the Company for the time being issued and paid up, upon the terms that the aggregate amount of the said stock for the time being in issue, and the interest thereon, shall rank *pari passu* as a first charge on the undertaking and revenue of the Company, the stock to be issued at such times, in such amounts, and on such terms and conditions as the board shall from time to time determine, for the purpose of redeeming by exchange or otherwise the outstanding debentures of the Company, and any other purpose to which capital of the Company may be lawfully applicable.

(B) That the board be, and are hereby authorised to make such provision as they think fit for the registration and transfer of mortgage debenture stock, and for the delivery of certificates thereof, and for the issue of stock warrants to bearer transferable by delivery, and of interest coupons attached to such certificates and warrants or otherwise, and for the conversion of warrants to bearer into registered stock, and of registered stock into warrants to bearer, and generally as to the form and incidents of all documents relating to the said stock, but so that no such provision be inconsistent with paragraph A of this resolution.

(C) That the board be, and are hereby authorised from time to time to purchase in the market and hold and deal with any amounts of such mortgage debenture stock for the purposes of any reserve fund or investment of the Company, and, with the sanction of a general meeting, to apply other moneys of the Company to the purchase in the market of any such stock for cancellation, and, with the like sanction, afterwards to re-issue mortgage debenture stock in lieu of all or any of the said stock so cancelled, provided always that the amount of mortgage debenture stock issued and outstanding shall never exceed the limit prescribed by paragraph A of this resolution.

The CHAIRMAN: That is the first resolution, which I beg to move.

The motion having been seconded, a discussion followed, in which Messrs. Marks, Griffiths, Newton, and Hirst took part.

The CHAIRMAN, in reply, said it was more advisable altogether to issue debenture stock than debentures, as a preference was generally felt by investors to go into a permanent stock rather than terminable bonds. With regard to the debentures outstanding, the holders could retain them until they expired, the directors having no power to deal with them otherwise without the consent of the holders. He then put the resolution, which was carried unanimously.

On the motion of Mr. NEWTON, a vote of thanks was passed to the chairman and directors, which the chairman acknowledged, adding, in reply to a question by Mr. Newton, that he thought it should be understood that British vessels had not been prevented from going through the Suez Canal, they had only been cautioned against passing through, but they could do so at their own risk.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).

Report of the directors for the half year ending June 30, to be presented at the twenty-second ordinary general meeting of shareholders to be held on July 19: The directors beg to submit, duly audited, the balance-sheet and accounts for the half year ended June 30 last, from which it will be seen that the gross receipts, including the balance brought from last account, amount to £21,279 7s. 11d., and the gross expenditure to £5,782 9s. 11d., leaving a sum of £15,496 18s. to the credit of revenue account. Of this, the sum of £3,950 has been placed to the reserve fund, increasing that fund to £47,000. After providing for the preference dividend, a balance of £8,546 18s. remains, out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income-tax, which will absorb £6,400, and leave £2,146 18s. to be carried forward to the current half year's account. The directors have pleasure in reporting that the cables have continued in good working order.

In the matter of the suit instituted against the Spanish Government at Havana for a return of the tax erroneously levied on the Havana-Santiago business, which was decided by the Court there in favour of the Company, and the decision appealed against to Madrid, appearance has been entered on behalf of the Company, and the case is now on the list of the Section of the Contencioso in the High Council of State waiting to be heard. The date of the trial has not yet, however, been fixed.

At the recent extraordinary meeting to fill up the vacancy in the office of auditor, caused by the death of Mr. Cowan, several shareholders remarked upon the inconvenience of having to call a special meeting in such cases, and suggested the expediency of altering the Articles of Association, so as to provide against similar contingencies. The directors, in order to meet these views, have, with the notice of the ordinary meeting, sent out a further notice of a special resolution, which will enable the shareholders, if they think fit, after the termination of the ordinary business, to effect a slight alteration in the articles to meet the case. The director who retires from the board at this time is Mr. Alexander F. Low, who, being eligible, offers himself for re-election. Mr. Thomas Greenwood, the auditor, who was elected at the extraordinary general meeting in May, in place of the late Mr. Cowan, also retires, and offers himself for re-election.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices July 12.		Business Done Week Ending July 12. Highest.	Lowest
Anglo-American	50,	51	52½	50
Do. Preferred	80,	81	82¾	79⅞
Do. Deferred	19½,	20¼	22¼	20
Brazil Submarine	11¼,	11⅝	11 7-16	11¼
Cuba	9¾,	10¼	10	9⅞
Do. Preference	16,	17	—	—
Direct Spanish	6¼,	6¾	6 7-16	6 7-16
Do. Preference	15½,	16½	—	—
Direct United States Cable	11⅝,	11⅞	12	11⅝
Eastern Telegraph	10½,	10¾	10⅜	10 3-16
Do. 6 per Cent. Preference	13,	13½	13¼	13¼
Do. 5 per Cent. Debentures, 1899	102,	107	—	—
Eastern Extension	11,	11¼	11⅜	11⅛
German Union	9¾,	10¼	—	—
Globe Telegraph and Trust Company.	6½,	6¾	6⅝	6½
Do. Preference	12¼,	12¾	12⅝	12¼
Great Northern	12¼,	12¾	—	—
Indo-European	28,	29	—	—
Mediterranean Extension	2,	2½	2	2
Do. Preference	8½,	9	—	—
Reuter's	12¾,	13¼	—	—
Submarine	265,	275	—	—
West India and Panama	1½,	1¾	—	—
Do. 1st Preference	8,	8½	8 5-16	8⅛
Western Brazilian	7,	7½	7 5-16	7¼
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	102,	105	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1⅜,	1⅝	1 9-16	1⅝
Oriental	⅜,	⅝	½	½
United Telephone	11¾,	12¼	12⅝	11¼

ELECTRIC LIGHT.

Electric Light and Power	½,	¾	⅝	⅝
Anglo-American Brush	24¾,	25½	26½	24⅞
Eastern Electric	3¾,	4	4¼	3¾

TRAFFIC RECEIPTS FOR JUNE, 1882.

Companies.	June, 1882.	June, 1881.	Incrse.	Decres.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,900	2,837	63	—
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	31,122	29,339	1,783	—
Eastern Telegraph Company	46,450	40,074	6,376	—
Great Northern Telegraph Company	22,560	—	—	—

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THE ORIENTAL TELEPHONE COMPANY, LIMITED.

BOARD OF DIRECTORS.

JOHN PENDER, Esq., M.P. (Chairman).
Sir ALEXANDER ARMSTRONG, K.C.B.
Sir JULIUS VOGEL, K.C.M.G.
PATRICK CARNEGY, Esq., C.I.E.
JAMES PENDER, Esq.
THOMAS ALVA EDISON, Esq.
Sir WILLIAM THOMSON, LL.D., F.R.S., M.I.C.E., ex-officio Director and Consulting Electrician.
JOHN P. BIGELOW, Esq.
WILLIAM W. CARGILL, Esq.
Colonel GOURAUD.
The Honourable GARDINER G. HUBBARD.

This Company is formed to provide Telephonic Communication by Exchanges and Private Lines in India, Ceylon, the Straits Settlements, Java, China, Japan, South Africa, Australia and New Zealand, Egypt, Turkey, Greece, and the Hawaian Islands, and elsewhere, wherever the Company may acquire rights.

Exchanges have already been Established in

ALEXANDRIA, CAIRO, CALCUTTA, MADRAS, BOMBAY, RANGOON, HONG KONG, SHANGHAI, AND HONOLULU,

And the Company will shortly open in

COLOMBO, KURRACHEE, CAWNPORE, AND ELSEWHERE.

PRIVATE LINES can be CONSTRUCTED in any of the countries comprised in the Company's field of operations. For further particulars apply to

3, Great Winchester Street, E.C., London, 10th March, 1882. W. G. HALL, *Secretary.*

THE EXCHANGE TELEGRAPH COMPANY, LIMITED.

Head Offices--17 & 18, Cornhill, E.C.; Stock Exchange, E.C.; 27, Regent Street, W.

Incorporated the 28th March, 1872, under the Companies Acts of 1862 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

The instruments supplied by the Company can be had to work either on single or double wires, and to print either on a slip or tape of paper, as has hitherto been the custom, or on a broad band of paper in column form.

The Company will supply householders and others with its

DISTRICT CALL SYSTEM.

By the aid of a small automatic telegraph instrument a Subscriber can at any hour, day or night, call a messenger, cab, or policeman, or give the alarm of fire, and will obtain the required assistance within three minutes of making the signal. Subscribers, when absent from their homes for a season, can leave their houses closed, and have them taken charge of by the Company, and rendered perfectly secure against burglars by a telegraphic communication with the nearest District Call Station of the Company, where a policeman will always be in readiness day and night to respond to calls.

Provincial combinations to work under the Company's Patents will be treated liberally.

The Company is also prepared to supply Municipalities with its system of

STREET FIRE ALARMS

as recommended by H. M. Postal Telegraph Department to the Metropolitan Board of Works for the Metropolitan Fire Brigade, and which has received favourable mention by Captain Shaw in his last annual report.

These Alarms have recently been considerably improved by the Company, and are acknowledged to be the simplest yet constructed.

All communications to be addressed to the Secretary as above.

NORTH-EAST COAST EXHIBITION OF NAVAL ARCHITECTURE, MARINE ENGINEERING, FISHERY, LIFE-SAVING, AND COAST-LIGHTING APPLIANCES.

To be opened at TYNEMOUTH on 6th SEPTEMBER, 1882, for not less than Twenty Days.

PATRONS.

His Grace the Duke of NORTHUMBERLAND, Lord Lieutenant of the County of Northumberland; President of the Royal National Lifeboat Institution.
The Most Hon. the Marquess of LONDONDERRY, Lord Lieutenant of the County of Durham.

PRESIDENT.

The Right Hon. the Earl of RAVENSWORTH, President of the Institution of Naval Architects.

VICE-PRESIDENTS.

The Right Hon. EARL PERCY, M.P.
Sir WM. GEO. ARMSTRONG, C.B., President of the Institute of Civil Engineers.
PERCY G. B. WESTMACOTT, Esq., C.E., President of the Institute of Mechanical Engineers.
With others.

Sections.	Presidents.
Naval Architecture	Charles Mitchell, Esq.
Marine Engineering	F. C. Marshall, Esq.
Fisheries	J. M. Ridley, Esq., Chairman of the Tyne Salmon Conservancy.
Life Saving	Commander C. F. W. Johnson, R.N.
Coast Lighting, &c.	Capt. Watson and Capt. F. Smith, Trinity House, Newcastle.
Civil and Sub-Marine Engineering	P. J. Messent, Esq., Engineer to the River Tyne Commissioners, and H. H. Wake, Esq., Engineer to the River Wear Commissioners.

In connection with the Exhibition there will be a LOAN DEPARTMENT, and the committee will be glad to receive exhibits of all objects of marine interest. WORKMEN'S approved MODELS, EXHIBITS of COAL and COAL SHIPPING APPLIANCES will be received. An Exhibition of ELECTRIC and other PATENT LIGHTS will be included.

Diplomas and Medals will be awarded.

Applications for spaces must be made before 1st August.

GEO. RENWICK, Hon. Sec.
SIDNEY OLD, Acting Secretary.

Offices: 21, Collingwood-street, Newcastle-on-Tyne.

INSULATED ELECTRICAL WIRE, Silk, Cotton, or India-rubber covered. Conductivity guaranteed. German Silver Wires for Resistance. Braided Handle Cord, Silk Cord for Electric Bells, &c.—WILLIAM RICKARD, Derby. London Agent (stock kept), EDWIN HOLLOWAY, 2, Gutter-lane, E.C.

TELEGRAPH CONSTRUCTION and MAINTENANCE COMPANY (Limited).

NOTICE is HEREBY GIVEN that the TRANSFER BOOKS of this Company will be CLOSED from the 10th to the 18th inst., both days inclusive, preparatory to the payment of an ad interim dividend of 12s. per share to all Shareholders on the register on the 10th inst.

By order, E. DICKENS, Secretary.

38, Old Broad-street, London, E.C.,
July 7, 1882.

CITY OF WINCHESTER.—The General Purposes Committee of the Town Council are prepared to receive TENDERS for LIGHTING the PUBLIC LAMPS of the City for one, two, or three years.

Full particulars to be obtained at the Town Clerk's Office. Sealed tenders to be delivered to the undersigned on or before the 19th inst.

The Committee do not bind themselves to recommend the acceptance of the lowest or any tender.

WALTER BAILEY, Town Clerk.

Guildhall, Winchester,
July 6, 1882.

PATENT OFFICE RESEARCHES.—An OXFORD GRADUATE, experienced in ELECTRICAL SUBJECTS and in the Investigation of Scientific Books and Documents, undertakes CONFIDENTIAL RESEARCHES for INVENTORS and others.

Not being a Patent Agent he has no interest, but that of his clients, in determining the exact Scientific and Commercial Position of all matters submitted.

Address "X.B.," Office of Electrician, 396, Strand.

VULCANITE.

Harburg India-Rubber Comb Company.

London Warehouse: F. WINTER.

138, LONDON WALL, WOOD ST., E.C.

EBONITE.

GRIFFITH & CO.

(LATE HARBOROW & CO.,)

ELECTRIC LIGHT ENGINEERS

AND

TELEGRAPH INSTRUMENT MANUFACTURERS

4, QUEEN ANNE'S GATE S.W.

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SLIP

Brazilian Telegraph Company.—The traffic receipts of this Company for the week ended July 7 amounted to £2,698.

Telegraphic Extension in Canada.—Telegraphic communication was established on June 23 between Winnipeg and Rapid City.

Society of Arts.—The Council of the Society of Arts have elected Dr. C. W. Siemens, F.R.S., as their chairman for the ensuing year.

British Guiana.—It is stated that the use of the telephone is spreading among the mercantile offices in the capital of British Guiana, West Indies.

Electric Light in Canada.—It is stated that large spars, 70ft. high, have been constructed for use in lighting the Chaudière Canal by electric lights.

Electric Light in Leeds.—It is stated that the Leeds Corporation have decided to light their Free Library, now in course of erection, by incandescent lamps.

Change of Name.—The company until lately known as the Electric Light and Power Generator Company will henceforth be known as the Maxim-Weston Electric Company.

Globe Telegraph Company.—The directors of this company announce a dividend for the quarter just ended of 3s. per share on the preference shares and 2s. 9d. per share on the ordinary shares.

Telegraphic Extension in South Africa.—Amongst other Bills that have been read a third time in the Cape Town Assembly is one providing for a loan of £300,000 for the construction of telegraph lines, &c.

West Coast of America Telegraph Company.—The gross earnings of this company—traffic and steamer—for the month ending June 30th, amounted to £3,425, against £3,405 in the corresponding period of last year.

The Telephone in Canada.—News from the Dominion says that the police telephone system in Toronto is to be greatly increased, and that several of the lumber camps on the Gatineau have been connected by telephone.

Telegraphic Communication with the Suez Canal.—The *Daily News* believes that the means of maintaining direct telegraphic communication with the Suez Canal is now under the consideration of Her Majesty's Government.

Telegraph Extension in Tasmania.—According to recent news from this colony, the new telegraph line from Mount Bischoff to the west coast had been commenced, under the superintendence of Mr. Fahey, inspector of telegraphs.

Western and Brazilian Telegraph Company.—The traffic receipts of this Company for the week ending 7th inst. were £1,719, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

Electric Light at Worcester.—An exhibition of art and industry was opened in this city in the early part of this week under the title of the "Worcestershire Exhibition." It is partially lighted by Brush arc lamps supplied by the Hammond Company.

The Telephone in Ceylon.—A public exhibition has been given by the Oriental Telephone Company of instruments fitted by its agents between two merchants' offices in the Fort at Colombo. The extension of the system is, says the *Colonies and India*, likely to spread quickly.

Electric Light at Windsor Castle.—The preparations for lighting portions of this castle by means of electric lights are progressing rapidly. The work is being done by Messrs. R. E. Crompton and Co., and the Maxim-Weston Electric Light Company.

Electric Light on the Embankment.—Owing to an accident to the steam-engine at the works of the Jablochkoff Company on the Thames Embankment, all the lights stopped burning on Monday night at 11:35, and it was believed that two or three days must elapse before they could be lighted again.

West Indies.—The cable between Trinidad and Grenada is interrupted; and, as the cable between St. Thomas and St. Kitts is not yet repaired, there is at present no telegraphic communication with the islands of St. Kitts, Antigua, Guadaloupe, Dominica, Martinique, St. Lucia, St. Vincent, Barbadoes, and Grenada.

The St. Gothard Tunnel.—After many contradictory reports as to whether locomotives propelled by electric energy where to be used in the St. Gothard Tunnel or not, we hear again that the attempt is to be made, and that experiments, for which the sum of 180,000fr. is set apart, are now being made at Berne with this object.

An Electrical Target.—It is stated that a target has been made use of during the Wimbledon meeting, which closes with the present week, which registered each shot fired, or rather each shot that struck it, on a dummy target placed some distance away, and electrically connected with it. This target is reported to have worked extremely well.

Tenders Wanted for Lighting.—The Gainsborough (Lincoln) Local Board are inviting tenders for lighting their district by electric or other lights for one year from the 8th of February next. For further information application should be made to Mr. Samuel Hayes, clerk to the board, 27, Market-place, Gainsborough. Tenders to be sent in by Sept. 2.

New Atlantic Cable.—A telegram from Philadelphia, dated July 18, states that Congress has finally passed the Bill authorising the Baltimore and Ohio Railroad to lay telegraph cables between the United States and Europe, with an amendment forbidding any conbination with other companies to fix rates. The Bill has been sent to the President for his action to be declared.

The Telephone for Diving Work.—A French naval committee has lately reported on the use of the telephone for diving operations. The transmitter approved as best is a small flat circular telephone, having interiorly two spiral magnets superposed. The Gaiffe telephone as a receiver is said to give good effects. Microphones (both the ordinary microphone and the Ader) are pronounced less advantageous.

Accident from Lightning. — A telegram from New York, dated Thursday week, stated that a large brick building in Texarkana, Arkansas State, had been struck by lightning on the previous night (Wednesday), and subsequently fell on an adjoining wooden building, used as a liquor saloon, completely crushing it. The saloon caught fire, and several people who were in it at the time were killed.

Electric Light in Theatres.—Experiments have been made at the Théatre des Variétés in Paris with Swan lamps fed by Faure accumulators, as a means of lighting up the stage. Eighty three lamps were used, and the same number of accumulators, the latter weighing sixty kilogrammes each. The result is said to have been satisfactory. The lamps and accumulators were supplied by the Société Force et Lumière.

Electric Light on Shipboard.—Last week Messrs.

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Robert Steele and Co. launched from their shipyard at Greenock a steel paddle steamer, called the "Lonsdale," which they have built to the order of Captain James Deane, of Melbourne. She is 200ft. long, 25ft. beam, and 10ft. hold, and intended to be very fast. She is being fitted throughout with incandescent lamps by the Swan Electric Lighting Company.

Direct United States Cable Company.—The directors of this Company have resolved to recommend a final dividend of 5s. per share (free of income-tax) such dividend to be payable on and after the 16th August next, making, with the interim dividends already paid, five per cent. for the year ending 30th June last, carrying forward £282 16s. 8d., after having carried to the reserve fund £9,531 9s. 1d., making it up to £264,000.

Electric Lighting in Belfast Harbour.—The contract for the electric lighting of the lower portion of Donegall Quay having expired the lights have been discontinued. Two of the four lights had, during the past few months, been exhibited during the entire night, and one of these, it is understood, was of very great assistance to sailors who brought vessels into port at night. The lights were supplied and erected by Messrs. R. E. Crompton and Co.

New Dynamo Machine.—We are informed that M. P. Jablochkoff, well known as the inventor of the Jablochkoff system of electric lighting, has brought out a new electromotor, which will, it is stated, give better effects than the motors at present before the public. The cost of the new dynamo machine is said to be small. We believe that an opportunity of seeing this machine will be afforded at the forthcoming exhibition at the Crystal Palace in the autumn.

New Company.—The formation of the Electrical Insulator Manufacturing Company is announced. The capital is £100,000, in £1 shares. The company have acquired an estate at West Wellow, in Wiltshire, which it is stated yields a clay very free from iron, and suitable for the manufacture of insulators, and it is to work this estate and manufacture all classes of insulators, battery jars, &c., that this company has been formed. Mr. E. H. Wilson is the secretary, and the offices are at 31, Lombard-street, E.C.

Electric Light and Gas.—At a recent meeting of the Standish (Lancs.) Local Board, in the course of a discussion on the Electric Lighting Bill and the cost of gas in the locality, it was remarked by the chairman that it was wrong "that they who rode, drove, and slept on a bed of coal, should pay the price for gas they did." Perhaps this may be explained on the same principle that market garden produce, fish, and other things often cost more in the localities in which they are produced or caught than in London.

The Telegraph at Wimbledon.—In the description of the result of the shooting at Wimbledon Camp in the *Daily News* for July 17, the following paragraph occurs:—"Tribute has been paid to one hardworking department at Wimbledon, let the labours of another equally industrious be now mentioned with honour. The telegraphists of the 24th Middlesex and the Civil Service sent no less than 210,000 words over their wires during the first five days of the meeting, and with so much accuracy that not a single complaint of any sort has been made."

The Telephone in Alexandria.—The Chairman of the Oriental Telephone Company has received a telegram from the company's agent in Alexandria, dated 15th inst., stating that, whilst many instruments and nearly all the lines have been destroyed, the Central Exchange is standing, and the general offices are safe, so far as the exterior shows. The agent has been instructed to restore communications as soon as it is prudent to do so. He is connecting the police stations by telephone. None of the company's *employés*, so far as the Board is aware, have lost their lives.

The Mull (Scotland) Cable.—The cableship "Morna," of Leith, Captain Howling, which has been chartered from the London and Edinburgh Shipping Company by the Post Office, has successfully repaired this cable, and telegraphic communication between the mainland and island has been resumed. It was discovered that the cable had been maliciously cut, probably by the crew of some vessel whose anchor had fouled it. After repairing this cable the "Morna" proceeded to Yell Sound, in Shetland, to repair the cable there. In addition to her ordinary crew this vessel has thirty cable men and a staff of electricians on board.

News from Alexandria.—We take the following items of information from the reports of the special correspondents to the daily press:—On Friday, 14th July, it was reported that the "Chiltern," telegraph ship, after transferring the Malta cable to the gunboat "Cygnet," went out and picked up the Cyprus cable—which had been left buoyed the previous day by order of the admiral—spliced it, and paid out four miles, and returned to her former position, having both the Cyprus and Malta cables on board. She was then (Friday) lying half a mile from the Lighthouse Battery, and in close communication with the admiral.

Severe Thunderstorms.—On Monday week severe thunderstorms took place in Scotland. At Pityot, near Muchalls, in the Stonehaven district, the farm buildings were struck and two cows killed. On the previous Saturday, at Blackhole Farm, near Brise, in the Banchory district, a flash of lightning killed two cows standing in the byre, knocking down a woman who was entering the byre at the moment. On Wednesday week the Braemar district was visited by a very heavy thunderstorm, which is reported to have caused considerable damage to the telegraph poles and trees in the neighbourhood. At the Post Office communication was interrupted owing to the coils of the instruments being fused.

Why the Electric Light Goes Out.—With reference to our Note of last week under this head, it is but fair to Messrs. Siemens Brothers and Co. to give the following extract from Mr. Haywood's report to the Commissioners of Sewers. He says:—"In District No. 3 (Siemens') there were 34 lamps, each assumed to be alight for 4,300 hours during the twelve months' experiment, which is equal to a total of 146,200 hours' lighting of a single lamp. The total number of failures in the lighting from all causes was 320, and their aggregate duration about 832 hours of a single lamp, or about ·57 per cent. of the entire lighting of the district for twelve months." In the district lighted by the Brush lamps the percentage was 2·21.

The Secresy of Telegrams.—In reply to Mr. Puleston, who asked the Postmaster-General whether he had now considered the question of destroying telegrams and the insurance by that means of the same freedom and secresy for telegrams as for communications by letter, Mr. Fawcett stated in the House of Commons last Thursday week that the practice of the Post Office had hitherto been to refuse to produce telegrams in court except upon a request by the sender or receiver, or upon the order of the judge. Some doubt having been expressed as to the legality of the course followed by the Department, he proposed to insert a clause in a Post Office Bill about to be introduced which would bring

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telegrams under similar provisions as to secresy as were now applicable to letters.

India Rubber, Gutta Percha, and Telegraph Works Company.—The next half-yearly general meeting of this company will be held at the Cannon-street Hotel, on the 25th inst., at 12 noon, for the purpose of obtaining the sanction of the shareholders to the payment of an interim dividend. An extraordinary general meeting of the company will be held subsequently at the same place for the election of an auditor of the company in the room of Mr. James Cowan, deceased. The company's share register will be closed from the 18th to the 26th inst., both days included. The directors state that the business for the past half year has been satisfactory, and they recommend an interim dividend of 5 per cent., or 10s. per share, payable on the 26th inst.

The Field Telegraph for Egypt.—A daily contemporary, speaking of the preparations being made for a campaign in Egypt, says:—"C troop of Royal Engineers will take out the most perfect field telegraph that has ever been prepared, and ten thousand poles have been got ready for it in the Royal Carriage Department. The poles, which are rather slender, are painted in conspicuous rings of black and white, and are shod with iron, so as to be easily planted in the ground. For several reasons an overhead telegraph is preferred to any other, and for a temporary use, as in this case, the light poles, which can easily be removed from place to place, are regarded as especially advantageous. The supply of wire being virtually unlimited, the telegraph may extend to about 250 miles."

Electric Light in Salford.—After four years' trial of the electric light, Mr. J. Bury, dyer and finisher, of Salford, near Manchester, has greatly extended its use in his works. The making-up room, formerly lighted by ninety gas burners, is now fitted with sixty British incandescent lamps, the change in the lighting having also brought about a better condition of the atmosphere of the room. By means of a switch, the foreman can light or put out any of these sixty lamps at will. The dye house is also lit by two Brockie arc lamps, thus enabling colours to be matched at night as well as in the daytime. The lights are driven by Gramme dynamo machines. The lights and machinery have been supplied and erected by Messrs. H. Bury and G. Tyndall, of Manchester, who are the local agents of the British Electric Light Company.

Telegraphic Communication with India.—Under this head, Colonel Fred. Burnaby writes to *The Times* of July 18 as follows:—"It may not have occurred to some of your readers that in the event of our relations with the Porte being broken off, England's telegraphic line of communication with her greatest possession—Hindostan—would be liable at any moment to be cut. Passing, as the wires do, one through Constantinople and Bushire, another through Odessa and Teheran, and the remainder *viâ* the Delta and India, we are practically dependent upon our friendly relations with the Mahomedan States for our electric communications with Hindostan. The Cape of Good Hope is united by wire with Aden and Bombay, Lisbon is connected with Cape de Verde; would it not be wise, without delay, to continue that line through St. Helena to the Cape, thus making us independent of any hostile Mahomedan combination?"

Telegraph Clerks' Grievances.—A meeting of the Dublin Telegraph clerks was held on Saturday night in Dublin, to receive the report of their delegate to the late conference held in London. The report stated that the feeling amongst the delegates was one of universal dissatisfaction at the inadequacy of the late scheme of revision, and at the manner in which it had been applied. The following resolution was adopted:—"That inasmuch as the Postmaster-General has declined to re-open the question of the settlement of our grievances, and has refused an independent investigation of the complaints made as to the application of the late revision, we regard his action in suspending Mr. Crichton, of Liverpool, for his condemnation of the manner in which the scheme was applied as being both unjust and arbitrary. That this meeting pledges itself to support the central committee in any steps they may decide upon relating to Mr. Crichton's suspension."

The Electric Light at Reading.—We have previously mentioned that during the late Agricultural Show at Reading Messrs. Heelas, of Minster-street and Broad-street, lighted up their extensive premises by electricity. The experiment was very successful, and we are told that over 33,000 visitors went to see it. The whole arrangements were carried out by the Electric Light and Power Generator Company, under the direction of Mr. Massey, and worked without a single hitch. For several days the engine ran during fourteen consecutive hours, the rooms being darkened so that the light was kept going during the day as well as in the evening. The visitors were particularly interested to see incandescent lights in water, lights overhead, and sewing machines worked by currents along one wire. Although mentioned before, we may again say that the Maxim incandescent and the Weston arc lamps were used during these experiments. The exhibition was continued for two or three days after the close of the show in order that the large numbers desirous of witnessing the effective lighting should be able to do so.

Freedom of Speech Amongst Telegraphists.—In the House of Commons on Monday Mr. S. Macliver asked the Postmaster-General whether it was true that a telegraph clerk had been suspended without pay for a fortnight, on the ground that he had made a speech (which he was not allowed sufficient time to explain or justify) at a meeting of telegraphists; and whether in future Post Office *employés* were to be debarred from meeting and discussing their affairs under similar penalties?—Mr. Fawcett replied that the telegraphist in question, according to the report of a speech of his in the newspapers, had charged his superior officers with official favouritism; and when called upon to correct the report or else to substantiate the charge, he at first declined to do either the one or the other, and afterwards offered to substantiate, if a fortnight were given to him for the purpose. Mr. Fawcett considered that in making a public charge of such grave delinquencies without being in possession of proof of its correctness the clerk had committed a very serious offence, and he had accordingly suspended him for a fortnight without pay.

Electric Light in the City.—At the meeting of the Commissioners of Sewers on Tuesday, the report of the Streets Committee on the recent tenders sent in for lighting the City, which was given in our last issue, was read. Mr. Innes subsequently moved "That the report be referred back, with instructions to forthwith carry out the electric lighting through the tendering companies, with the right of private lighting in the districts for three years added to their contracts, reporting in the first instance on the cost of the street lighting after tenders have been made on the footing of the right of private lighting." There was a good deal of discussion on this motion, but eventually it was lost by 17 votes against 6. A subsequent motion by Mr. Peebles to the effect "That the report of the Streets Committee (of June

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20th) be referred back to them to consider the advisability of adopting the electric light in the streets of the City, and also to consider the advisability and best means of making arrangements for the supply of electricity to this City for all purposes, with power to consult electricians and engineers thereon, and to report to this Court without delay," had to be withdrawn, as most of the members of the Commission had left by that time.

The FitzGerald and Gumpel Lamps.—An exhibition of these lamps has been given during the week by the Phœnix Electric Light and Power Company, at No. 190, Westminster Bridge-road, S.E. The FitzGerald incandescent lamp is composed of a carbon filament in vacuo, and resembles all other incandescent lamps in that respect, but there are details of construction which are peculiar to this lamp only. The carbon is made from Swedish blotting paper, parchmentised by a new process, and subsequently carbonised. It is then mounted on platinum wires in a glass globe. A third wire of iron is introduced into the globe, and connected with the conductors, and on this wire is wound a strip of magnesium. When as good a vacuum has been obtained as is possible with a Sprengel pump, the glass globe is sealed, and the current turned on for a short time. The iron wire becomes red hot and heats the magnesium, which consumes the last particle of residual oxygen that may be left in the lamp. This the inventor states adds greatly to the durability of the carbon, and the efficiency of the lamp. The Gumpel lamp is on the arc system. As we shall hope to describe this lamp with illustrations before long, we shall not say much about it here. The feed is constant, and it is the positive carbon which is fed forward in this case. The lamp seemed to burn well when we saw it. Both the arc and incandescent lamps were supplied with current from a small Gramme machine driven by one of Marshall and Co.'s portable engines. Mr. Gumpel also showed an invention for steering vessels by means of a dynamo connected by gearing to the rudder, and also with a commutator and other apparatus on the bridge of the vessel. So that by turning a handle to right or left, the helm could be made to follow to starboard or port, as the case might be.

Telephonic Exchanges.—In the House of Commons on Monday last, Mr. Cross asked the Postmaster-General whether he had yet come to any decision as to the application which had been made by various companies for licenses to establish and work telephonic exchanges. In reply, Mr. Fawcett said:—"I have to state that I have received numerous applications to grant telephonic licenses, not only in places where telephone exchanges have been established by private companies, but also where they have been established by the Post Office. Deputations have waited upon me, representing the United Telephone Company and other companies connected with it, strongly urging that in the interest of the public it was desirable that private companies should have an opportunity of competing against the Post Office in those places where telephone exchange business has hitherto been conducted by the Post Office alone. I have had similar applications to allow telephone exchange business to be established in places where the United Telephone Company or one of its branches has an exchange. After giving the matter very careful consideration I have come to the conclusion that it would not be in the interest of the public to create a monopoly in relation to the supply of telephonic communication. I am, therefore, prepared to favourably entertain the proposals that may be made to me by responsible persons to grant new telephone licenses under conditions which may be regarded as giving adequate protection to the public and the Department. In case it may be supposed that inconvenience may arise from the multiplication of wires, I may remark that the license of the Postmaster-General to establish a telephone exchange confers no special power whatever to erect poles and wires on, or to place wires under, any highway or private property. The persons to whom a license may be given will have to make their own arrangements with the local authorities, and with any persons whose property may be affected. It may be well to add that the license of the Postmaster-General confers no authority to carry on telephone business with any instrument the use of which would be an infringement of any patent."

The Origin of Thunderstorms.—On the 7th of July, Mr. B. G. Jenkins, F.R.A.S., read an interesting paper on this subject at a meeting of the Dulwich College Geological Club, held at the Old College. According to the author a thunderstorm is generally regarded as a manifestation of atmospheric electricity. Electricity is without doubt actively present, but its duty is, he maintained, largely to act as a match to produce the chemical unions of which the thunder is the audible effect. If a thunderstorm is the result of an excess of electricity in the atmosphere, it is remarkable that they should be so prevalent in June, when the atmospheric electricity is at a minimum, and not happen in January, when it is at a maximum. That moisture is not the cause of thunderstorms is evident, for moisture in the winter months increases atmospheric electricity, but diminishes it in summer. Besides, thunderstorms are much fewer in number and less violent over the oceans than over the continents. The vast quantities of water in the rapidly-formed thunder clouds are the effect and in no way the cause of the storm. Count Volta showed that gases emit positive electricity when being condensed, and in this and the consequent rapid formation of dense clouds Mr. Jenkins considered the true explanation lay. The condensation was due to a chemical change produced in the union of the oxygen and nitrogen of the atmosphere with hydrogen. The two former are abundant; the difficulty is to account for a large and sudden supply of the latter. There are, however, reasons for believing that the outside layer of our atmosphere is largely composed of hydrogen, and that under certain atmospheric conditions portions of this vast layer are whirled down into the mixture of oxygen and nitrogen around and above us. The mere friction of the particles would be sufficient to produce an electric spark, causing a large portion of the hydrogen to unite with oxygen, forming water; another to unite with nitrogen, forming ammonia; and another to unite with oxygen and nitrogen, to form nitric acid. Each great flash is followed by a sudden downpour of rain, and especially of hail, indicating by the great change of temperature some vast chemical union. This can be no other than the formation of water, which, as is well known, would be accompanied by flame and explosion. The light produced in the sky during a thunderstorm has been divided into three kinds—first, forked lightning; second, sheet lightning; third, ball lightning. The first only of these, he held, was true electricity. The second is the most frequent, and appears to be produced inside the cloud, lighting up the mass, being almost wholly flame, due to the combustion of hydrogen in oxygen, and other chemical changes—the thunder being not so much the noise of the electric discharge as the report of the explosions taking place during the chemical union. Ball lightning is probably not electricity, but a mass of gas in intense ignition. The comparative harmlessness of the last two would seem to indicate their non-electric character.

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ELECTRICITY.

ABSTRACT OF TWO LECTURES BY PROF. G. CHRYSTAL.*

LECTURE I.

The subject of this and the following lecture is electricity. This word connotes much that is definitely ascertained, much that is fancied to be known, and much that is confessed by all to be unknown. It is well, then, at the outset, to indicate the route we are to follow through so wide a subject. In the first place, we are to set aside our curiosity as to the real nature of that to which we give the name electricity; we are not to inquire into the nature of the thing itself; we are to turn our backs resolutely on the mystic mazes of molecular physics wherein the dynamical explanation of electricity is doubtless to be found, and to look steadily at the manifestations of electricity in the various phenomena of the laboratory and workshop. Our question is not what electricity is, but what does it do? Nor of its doings are we to be led aside by those phenomena that are little understood, or as yet but feebly manifested. We are to look only at those that are best known, most within our power of calculation, and at the same time, so far as our limited vision goes, most likely to serve our practical purposes. We are to look at electricity as the agent that rings our bells, lights our streets, silvers our spoons—if solid plate happens to be beyond the depth of our purse—and will in the not distant future brush our boots, grind our coffee, and take us quietly to church on a Sunday without disturbing either cabmen or horses. In short, we are to look at electricity as a storer and transmitter of energy.

Energy is another of those potent words wherewith the learned conjure nowadays to the mystification of their lay brethren. It is little understood by the British public, but some glimpse of its meaning is clearly necessary for us to-night, for it is the main thing we are to talk about. The two great difficulties in apprehending it are—1st. That it denotes something which is unseen. 2nd. That the idea which it names is new to this generation. Every one of any education is now familiar with the principle called "Conservation of Matter," but comparatively few have yet grasped the notion of the "Conservation of Energy." We all know that matter is indestructible. To-night must be impressed upon you, along with the idea of energy, the notion that it is also indestructible.

Let us make an indirect approach along an old fashioned road. Let us follow for a moment that metaphysical phantom "Force," on whose real nature and problematical existence my colleague, Professor Tait, has of late thrown so much light. When a body previously at rest to relatively neighbouring bodies begins to move, we explain the fact by saying that force has been exerted upon it. Now, to that I append the statement that in general when force has been exerted and a body has in consequence moved, or been helped in its motion, *work has been done*, and we may say that work has been done by the force or by the exerting agent. You are, of course, all familiar with the fact that two very different results may follow from *work done*. 1st. The result may be matter set in motion. 2nd. The relative position of certain portions of matter, let us say the configuration of a material system, may be altered.

In the first case we have what is termed *kinetic* energy, in the second *potential* energy. The *kinetic* energy of a moving body is proportional to the mass and the square of the velocity conjointly, and has the value $= \frac{1}{2} M v^2$, where $M =$ mass and $v =$ velocity. As an example of kinetic energy we may take a cannon ball after it has left the cannon. Its power of doing work depends on its mass and on its velocity. One of the simplest cases of *potential* energy is that of a body placed in such a position that by falling lower it acquires kinetic energy and thus has the power of doing work. For example, water in a reservoir in a high position possesses advantages which water at a lower level has not. A great deal of work may be got out of it as it falls to a lower level. A bent bow is in a similar position of advantage, and when it is discharged the energy of position of the arrow is converted into energy of motion.

I have said that work expended produces energy—kinetic or potential. Conversely, where there is kinetic or potential energy there is capacity for doing work. Thus, the cannon ball projected from the gun batters down a wall, the arrow penetrates a target, or a wound-up spring continues for days or weeks to produce kinetic energy in a clock.

Energy is often defined as the power of doing work. But we see in fact that kinetic energy, potential energy, and work, are all one and the same thing, in so far that they are measurable in a common unit. We may take to-night for our unit of work the work done in raising an imperial pound of matter through a foot against the earth's attraction at Edinburgh. Then the unit of kinetic energy, or of potential energy, is that amount of each which is produced by the expenditure of a unit of work. When any agent does 550 foot-pounds per second, *i.e.*, 33,000 foot-pounds per minute, it is said to work at the rate of a horse-power. What we mean when we talk of an engine of so many horse-power is that it is capable of doing so many times 550 foot-pounds of work per second.

Dynamical Theories of Natural Phenomena.

Every problem which deals with matter in motion and involves the consideration of three and only three fundamental elements, viz., *mass*, *space*, and *time*, and which is completely solved when we know exactly how each of these enters, is called a *dynamical* problem, and every explanation of natural phenomena depending on *mass*, *space*, and *time* alone is called a *dynamical theory*.

Hitherto I have been illustrating dynamics with systems whose motions and configurations you can see; but now I have to ask you to follow me into the far larger region of dynamics, where both motions and mechanism are as a rule invisible. The recent progress of physical science, of which you hear so much, may be summed up thus, that it is being gradually shown, and has in a great measure been already demonstrated, that the explanation of all our sensations, in other words, of all our knowledge of the external world, is purely *dynamical*. A dynamical theory is now the ideal of physical explanation. When a physicist has shown that any phenomenon is an affair of *matter*, *space*, and *time* he has done with it, he aims at no more and he hopes in all cases for no less. I may mention the cases of sound, light, and all its concomitants—heat, touch, smell. In all these cases matter, however fine or subtle, is constrained or is moving. Quite true, the mechanism of these motions is so delicate that even the most powerful microscope cannot detect it, and in many cases the physicist cannot exactly describe the matter which moves, but the evidence, although indirect, is irresistible. Energy, kinetic or potential, can be traced as a central feature in every case.

I have now to impress upon you that all these different kinds of energy are one and the same. The same in the practical sense that they are definitely convertible, so that we can say how much of one goes to make so much of the other. The classification into different kinds is a mere experimental convenience, and carries with it no essential distinction.

If we could trace completely the whole course of any physical phenomenon within a limited area it would be found that no energy has appeared spontaneously, or has been annihilated; if there is more at the end than the beginning it has come from without; if there is less it has gone from within. In other words, energy is indestructible; it may assume different forms like matter, but like matter it is *conserved*. This is the great principle of the conservation of energy, the most brilliant of the intellectual children of the nineteenth century.

It must never be forgotten in applying this law of conservation that *all* the different parts of any phenomenon must be

* The author of these lectures consents, with some reluctance, to the publication of the following rough notes, doubting whether a public much spoiled by finished productions in the way of popular lectures will be interested in them. Readers will understand that, after the introduction, what follows is merely the skeleton of a spoken lecture. The interest of the thing, so far as it may have any, is that the most prominent electrical phenomena are strung together as illustrations of the conservation of energy.

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taken into account. When this can be done completely the whole of physical science will become a series of corollaries drawn from the one law of the conservation of energy. Ignorance of detail, such as I have mentioned, constrains us meantime to fill many a gap with empirical laws drawn from experience, and oftentimes even with mere assumptions; but in the main the operations of this law can be clearly traced throughout all nature. I now proceed to illustrate its operation in electrical phenomena.

Statical Electricity.

You are all aware that oppositely electrified bodies attract each other, and that like electrified bodies repel each other. In order to separate two dissimilarly electrified bodies, or to bring together two similarly electrified bodies, work must be done. In the former case the bodies have potential energy by virtue of their distance, in the latter by virtue of their proximity.

This machine (a Holtz machine) is simply an ingenious contrivance for taking advantage of the facts above mentioned for the purpose of converting work into electro-static or electro-kinetic energy as the case may be. At present the machine is excited, and Mr. Lindsay finds it much harder to drive than he would after it had stood for some time and its vital organs had lost their opposite charges. The question is what becomes of this extra work. Those of you that are sufficiently near will already be able in part to answer. Light will be seen at the combs, a hissing sound will be heard, and a peculiarly pungent odour, due to ozone, will be perceived, which represents a certain amount of potential energy of chemical separation.

But I can divert Mr. Lindsay's energy into a more striking form. I separate the terminals, the machine works for a little, accumulating electro-static energy, and then a brilliant spark passes in which this energy is transformed

1st, into the energy of sound vibrations, some part of which has been taken up by every tympanum in this room.

2nd, into the energy of luminiferous vibrations, in which again every eye in the audience has shared.

3rd, careful measurement would undoubtedly show a considerable development of heat in the air which the spark has ruptured.

I can vary this experiment in an interesting manner by increasing the capacity of the electrode of the Holtz machine. This I do by connecting with it an accumulator of statical electricity. [A Leyden jar was here charged and discharged.] You will see that more turns are required to cause the spark to pass, but the additional work thus absorbed is represented by a brighter and louder-sounding spark.

I shall next show you that the electro-static or electro-kinetic energy which represents Mr. Lindsay's work, can be reconverted into the kinetic energy of motions visible to the eye. I connect one of these parallel plates of metal with one terminal of the machine, and the other plate through the earth to the other terminal. I hang this large pith ball between the plates, and you see that when the machine is worked it vibrates so rapidly to and fro that a low musical note is heard. The energy of this motion comes from Mr. Lindsay's work, and this is, therefore, a case of electrical transmission of energy. [Then followed, as an additional illustration, the well-known experiment with the electric windmill.]

In the experiments, where a spark passes between two metallic terminals, the intervening air plays the part of an insulator, that is, of a body which stops the passage of electricity. It acts, in fact, like an elastic string, which may be stretched up to a certain point, and thus made the recipient of potential energy, but which breaks after the stretching has been carried beyond a certain limit, and then expends that energy on the fingers of the operator. Besides dry air, glass, vulcanite, gutta percha, sealing wax, shellac, silk, &c., are good insulators. If I were to connect one electrified body with another by one of these, no communication of electrical properties would take place. The result is very different, as you will see, if the connection is established by means of a metal. I connect this Leyden jar by means of a long wire with the electrode of the Holtz machine. Mr. Lindsay will do a little work for us. Now, I remove the wire, and here [jar discharged] is the proof that something has been communicated.

I now show you this Voss machine. It is in action, and sparks are passing between the electrodes. Since these sparks represent a certain amount of energy, work must be done on the moving plate of the machine. Hence there must be a reaction on the driving gear, and, therefore, if the electrification of the machine were kept up by sending a current from the Holtz machine into this one, the latter would be driven round and would become an electromotor. [This experiment was then shown, and the general principle of reversibility insisted on.]

Transfer of Electricity Along a Wire.

Let us now direct our attention to what goes on in the wire, which forms, as we said, our means of transmitting energy to a distance. This part of the subject is the most technical into which I propose to lead you in the course of these lectures, and although you may be somewhat wearied before I have done of the details through which I must conduct you, yet I am confident that, when I come to show you their applications, you will be satisfied that I have not asked you to make a vain effort.

We express the result of experiment by saying that electricity has been conducted along the wire. I could easily advance experiments to show that this something called electricity is capable of accurate measurement. Yet it is not matter, and for many reasons it would be a mistake to suppose that anything analogous to the flow of water or gas takes place along the wire. Nor is it energy, for the same quantity of electricity represents different amounts of potential energy according to circumstances. I can show you experimentally that the transmission is mediate, that is, that it can be traced all through the wire, and, what is more extraordinary still, that the phenomena accompanying transmission are to be traced in the surrounding medium, as well as in the wire. [Experiments were here shown (1) with a vacuum tube, (2) with a galvanometer, and (3) Reis's thermo-electrometer was described.]

Electromotive Force.

The tendency of electricity to pass from a body A to another B is called the electromotive force between them. It is measured by the work that would be done upon a unit of positive electricity in passing from the one to the other. Difference of pressure of fluids, and difference of temperature in thermal measurements are somewhat analogous to electromotive force. Sometimes electromotive force is expressed by talking of the potential of A and the potential of B. It is then the difference of the potentials of A and B. It is clear that there can be no electromotive force between two parts of the same conductor when it is in electrical equilibrium, for if there were there would be passage of electricity from the one part to the other. This gives us the means of measuring electromotive force by means of an instrument called an electrometer. The leading principle is that we measure electromotive force by means of the force between electrified bodies. [A schematic diagram of the working parts of a quadrant electrometer was projected on the screen and explained.]

Rate of Transference.—Current Resistance.

The rate at which the electricity flows through the wire is measured by the amount that passes any section in a second, and this amount is called the current strength, or simply the current. I have already shown you that the electric current manifests itself by magnetic action in the surrounding medium. We must now look at this action a little more closely, for upon it rests our principal means of measuring current strength. The exact law of this action is as follows: Consider only the north pole of the magnet, then the action of the current on that pole is a force perpendicular to the plane through the current and the pole, directly proportional to the strength of the current, and inversely to the distance of the pole. The action on the south pole is exactly opposite to that on the north.

We are now in a position to prove experimentally

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Ohm's Law.

If we take one and the same length of wire, and cause different electromotive forces to act between its ends, we shall find the current to be proportional to the electromotive force. If we take different wires we shall find that the E.M.F. required to send a given current through them is different. If I double the length of the wire, the material and section remaining the same, the E.M.F. required is double. If I keep the length and material the same, and double the area of the section, the E.M.F. required is halved. That by which we must multiply the current in any wire to get the E.M.F. required to produce it is called the resistance of the wire. We indicate this law symbolically thus:—

$$E = C R$$

Where

E = Electromotive force.
C = Current strength.
R = Resistance.

$$R = \rho \frac{l}{s} = \rho \frac{l}{r^2}.$$

R = Resistance.
ρ = A factor differing for different materials (specific resistance).
l = Length of the wire.
s = Section of the wire.
r = Radius of the wire.

If we now reflect that the work done upon every unit of positive electricity that passes is 8 E, by our definition, and that C units of positive electricity pass every second, then we see that the amount of work done per second is $E \times C$. Expressing this result in the various units now in use we have the following important formulæ for

Work Required to Maintain a Current in a Given Wire:—

$$W = E C\ 10^7 \text{ ergs. per second.}$$
$$= \frac{E C}{746} \text{ horse-power.}$$
$$= \frac{E C}{1,356} \text{ foot pounds per second.}$$

Sources of Electromotive Force.

We have seen that every current flowing through a given wire requires a definite expenditure of energy to keep it up. Let us look for a moment at the different sources from which this energy may be drawn. In the case of the Holtz machine, Mr. Lindsay furnished us with what was needful to maintain the current. In the galvanic battery, which was until lately the ordinary means of producing a steady current, the energy of chemical separation is the source. It is easy to show that energy can be obtained by allowing two substances to combine chemically. The most familiar case is, of course, that of the combination of oxygen and carbon in the combustion of coal. If we allow sulphuric acid to combine with zinc, so as to form sulphate of zinc, we can ascertain the amount of energy given forth in the form of heat. This heat energy represents the potential energy of separation of the sulphuric acid and the zinc. Advantage of this is taken in the cell of Smee, which is one of the simplest of the galvanic batteries, and which I take on that account for illustration.

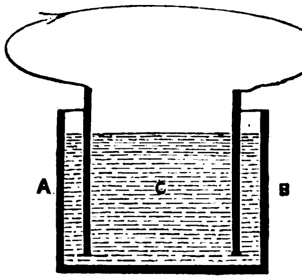

FIG. 1.

A B represents a section of such a cell, one pole of platinum, and the other a zinc plate immersed in the liquid, which is dilute sulphuric acid. The plates are joined by a copper wire, and the current flows through the wire from the platinum to the zinc. If E be the electromotive force of the cell, and C the current in the wire, the amount of energy that must be furnished per second to keep up the current is, as we have seen, E C; and hence the amount of chemical energy of separation which disappears every second owing to the formation of sulphate of zinc in the cell is E C. This energy instead of being converted immediately into heat is represented by the electro-kinetic energy of the current C.

In thermo-electric batteries two different metals (Fig. 2) are connected in circuit, and heat is applied at one junction,

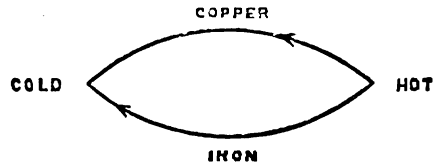

FIG. 2.—Thermo-Electric Arrangement.

while the other is kept cold, that is, heat is absorbed at one junction, but given out in a less amount at the other. The difference accounts for the energy of current.

All these sources of electro-kinetic energy are now eclipsed by the dynamo machine, which acts on the principle of electro-magnetic induction. Further discussion, however, of this must be deferred for a little until we have investigated the various ways in which we can avail ourselves of electro-kinetic energy, when it has been produced, and turn it to useful purposes. I first proceed to show you, in a variety of ways, how electro-kinetic energy can be transformed into heat, and as an extreme case into light.

[A number of experiments were performed with the aid of a dynamo machine. The lectures were given in the hall of the Industrial Museum. An A Gramme machine, belonging to Professor Tait, was at work in one of the cellars of the University, about 100 yards or so from the lecture room. The Gramme was driven by a $3\frac{1}{2}$ horse-power gas engine. A cable lent by the Brush Electric Light Company, carried through one of the windows, was used to conduct the current to the lecture table. In the engineer's workshop was another gas engine driving a Brush dynamo, giving current for the Brush arc lamps, or the Lane-Fox incandescent lamps, the current being turned into the lamps wanted by means of a switch.]

Among the experiments shown were:—

(1) The gradual heating of a yard and a half of iron wire to a bright red heat by passing through it the current from Professor Tait's A Gramme machine.

(2) A thin carbon rod was heated to a white heat, and Joules's law $H = C R^2$ explained.

(3) The Werderman semi-incandescent lamp was shown in action. In this lamp two rods of carbon impinged against a flat plate of carbon. The current dividing between the rods maintained a beautiful soft light at each point.

(4) The current was made to boil water, and cook an egg, and a calculation made as to the horse-power required to boil a kettle containing 4lb. of water in four minutes. Result about $3\frac{1}{2}$ h.-p. approximatly.

The idea of an incandescent lamp was modern, and practical lamps had been obtained only within the last two years or so. This lamp consists of a filament of carbon heated white hot in a vacuum. The difficulties met with in the construction of these lamps were first to obtain and maintain a good vacuum; second, to make and maintain good connection between the carbon filament and the conducting wires; and, thirdly, to obtain a uniform section of filament. Different inventors had used various materials from which to obtain their carbon filament. Thus, Edison used a Japanese bamboo, Swan cotton thread, Maxim cardboard, and Lane-Fox bark fibre. The success of such a lamp depended to a great extent upon its durability.

The advantages of the light were pointed out, and eight Lane-Fox lamps, specially sent down by the Brush Company, with a dynamo, were exhibited in action. They worked very well, and were much appreciated. This was the first public exhibition of incandescent lamps in Edinburgh.

Experiments were now made to show the spark at the

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breaking of contact and the volatilisation of the electrode; also to show that the colour of the spark depended on the materials used, copper giving a green colour.

The spark, and then the voltaic arc, between carbons, was shown and projected on the screen. Inasmuch as the carbon gradually decreased in length when used for electrodes, inventors had to obtain means of keeping the carbons at a proper distance apart by moving them in the exact rate at which they were consumed. The results of these attempts were seen in the various arc lamps, such as that of Brush (shown), which is a pure arc lamp.

By another experiment it was shown that the electrokinetic energy of the current could be reconverted into the potential energy of chemical separation. The current of the Gramme machine was sent through a large voltameter, the separated oxygen and hydrogen filled a small bladder in a minute or two. On applying a lighted match the chemical energy was again transformed, part of it appearing in the sound of a violent explosion, which impressed the audience not a little.

ON THE GRADUATION OF GALVANOMETERS FOR THE MEASUREMENT OF ELECTROMOTIVE FORCES AND CURRENTS IN ABSOLUTE MEASURE.

BY THOMAS GRAY, B.SC., F.R.S.E.

ERRATA in the first part of this article:—Page 178, col. 1, line 10, for "to" read "so," and for "single" read "simple." Page 178, col. 1, line 16, after "necessary" insert "corrections." Page 178, col. 1, line 36, for "vertical" read "vertically." Page 178, col. 2, last line, in the formula, for "8" read $\frac{8}{3}$.

(CONTINUED FROM PAGE 178.)

We have next to consider how we can best take into account the form and dimensions of the coil. For most instruments as supplied by the makers it is impossible to determine by calculation with any degree of accuracy the deflection of the needle which would be produced by a given current sent through the coil. Hence, for the purpose of graduating galvanometers in absolute measure we find it necessary to construct a coil of such form and dimensions as we can easily measure with accuracy. For this purpose there is, perhaps, nothing better than some modification of the old form of tangent galvanometer with a coil of large radius. In making up such an instrument to be used as a standard the following points ought to be carefully attended to. The wire of the coil ought to be sufficiently thick to prevent any risk of damage, due to heating, from the strongest current that is likely to be sent through it. The coil should form a circular ring, the diameter of which is great compared with its other linear dimensions. For convenience and accuracy of construction it is best to make the ring of rectangular section. The total length and resistance of the wire should be accurately measured before the coil is wound, and its resistance again measured after the winding has been performed, and the result of this latter measurement compared with the former. The measurement of the length of the wire is important, as this enters into the subsequent calculations. If the resistance before and after winding agree, the wire may be assumed to be properly insulated, and not to have sensibly stretched during the operation of winding; but if it be less after than it was before the coil must be rejected as untrustworthy. If it is greater the wire must have been stretched by the winding, and therefore the number of turns and the measured internal and external diameters of the ring have to be depended upon in the subsequent calculations. It is well to stretch the wire slightly before winding it in order to harden it, and thus as much as possible avoid any such change of length. The number of turns must also be determined, and the diameters should be measured in order to check the previous measurement of length. The mean radius is most accurately obtained by dividing the length by $2\pi n$ where n is the number of turns. The breadth and depth of the rectangular section have also to be measured, if great accuracy is aimed at in the experiments for which the instrument is intended. The needle of this instrument should consist of one short magnet, or a system of short magnets suspended by a silk fibre, with the centre of the magnetic axis of the magnet, or system of magnets, as exactly as possible in the centre, of the ring, and in its medial plane. This needle should either have a mirror or a light horizontal index five or six inches in length, rigidly attached to it for the purpose of allowing its deflections to be observed with accuracy. These deflections may be observed either in degrees or in tangents by means of a circular scale divided to degrees or tangents placed under the outer end of the index. The centre of this circular scale must be placed exactly under the centre of the magnetic axis of the needles. In order to prevent errors from currents of air or parallax the needle and index should be enclosed in an air-tight box with a glass top and mirror bottom. While observations are being made the mirror should be level, and the eye of the observer should be so placed that the index covers its image in the mirror. It is convenient for purposes of observation to have the index fixed with its length at right angles to the axis of the needle; and, assuming that the line joining the divisions 0° and 180°, or the radius passing through the zero of the scale is placed accurately at right angles to the plane of the coil, it is necessary, in order that the instrument should give equal deflections on the two sides of zero, that the axis of the needle and the line through the suspending fibre and the point of the index should be exactly at right angles to each other. To test whether the centre of the magnetic axis is exactly above the centre of the scale, draw three radial lines, one through the zero, and the other two making an angle of about 45° on opposite sides of this, and observe whether the needle, by being deflected, can be brought into parallelism with each of these lines. To test whether the index is at right angles to the magnetic axis of the needle draw two lines on a piece of cardboard, and placing it under a long thin magnet suspended by a silk fibre, turn it until one of the lines is exactly parallel to the line joining the poles of the magnet. Then suspend the needle and index over the paper, and observe whether the index sets itself parallel to the other line. That the radial line through the zero of the scale is at right angles to the plane of the coil may be tested either by sending the same current through the coil in opposite directions, and observing whether the deflections are equal on the two sides of zero, or by suspending a long thin needle over the line (the coil being in this case at right angles to the magnetic meridian), and observing whether a current sent through the coil produces any deflection. This needle should project equal distances on the two sides of the coil, because if this is not attended to there will be a tendency to motion of translation when the current is sent through the coil. The suspending fibre should, of course, be attached to the needle at a point vertically above the centre of the magnetic axis, so as to make the needle stable in a horizontal position, the centre of inertia of the system being supposed in the line of suspension when the index is horizontal. When a mirror is used instead of an index the coil is placed in the magnetic meridian, and therefore parallel to the axis of the needle, by observing when the deflections due to the same strength of current are equal on the two sides of zero.

Let us suppose that we have such an instrument as that just described, and let the mean radius of the coil be R, the breadth of the ring $2b$, and its depth $2d$, and suppose a current of C units per unit area of section of the coil to be sent through it. (By a current of C units per unit area of section of the coil is meant such a current that if its strength were multiplied by the number of turns per unit area of section the product would be C. The current is here measured according to the "absolute" system electro-magnetically, that is to say, unit current is that which, circulating in a circular arc of unit length and of unit radius, would act on a unit magnetic pole placed at the centre with unit force. A unit magnetic pole is that pole which, placed at unit distance from an equal and similar pole, would be repelled with unit force.) Then the magnetic force due to the current flowing through an element $dx\,dy$ of the section on a unit pole placed at the

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centre of the coil will be $f_1 = 2\pi C \frac{dx\,dy}{x^2+y^2}$, where the origin of co-ordinates is at the centre of the coil. The component of this force tending to move the pole in a horizontal line at right angles to the plane of the coil is

$$f_2 = 2\pi C \frac{y\,dx\,dy}{(x^2+y^2)^{\frac{3}{2}}}.$$

Hence we have for the total horizontal force on the pole

$$F = 4\pi C \int_0^b \int_{R-d}^{R+d} \frac{y\,dx\,dy}{(x^2+y^2)^{\frac{3}{2}}}.$$

Integrating we find

$$F = 4\pi C b \int_{R+d}^{R+d} \frac{dy}{(b^2+y^2)^{\frac{1}{2}}}$$

$$= 4\pi C b \log \frac{R+d+\sqrt{(R+d)^2+b^2}}{R-d+\sqrt{(R-d)^2+b^2}}. \quad . \quad (3)$$

Now, if a be the deflection of the needle caused by this current, we have from the equation of equilibrium

$$F = H \tan. a,$$

and therefore

$$H \tan\, a = 4\pi C b \log \frac{R+d+\sqrt{(R+d)^2+b^2}}{R-d+\sqrt{(R-d)^2+b^2}},$$

from which we obtain

$$C = \frac{H \tan. a}{4\pi b \log \frac{R+d+\sqrt{(R+d)^2+b^2}}{R-d+\sqrt{(R-d)^2+b^2}}}. \quad . \quad (4)$$

When b and d are small compared with R, this equation becomes very nearly

$$C_0 = \frac{H R \tan. a}{2\pi n} = \frac{H R^2 \tan. a}{l}, \quad . \quad . \quad (5)$$

where l is the total length of wire in the coil and C_0 the strength of the current flowing through the circuit, or, which is the same thing, $\frac{4bd}{n}C$.

The error due to using equation (5) instead of the exact equation as deduced from equation (4) is only about $\frac{1}{20}$ per cent, when b and d are each $\frac{1}{10}$ of R, and, as this is a larger value of b and d than would in most cases be adopted, the approximate formula may be taken as giving the value of the current to a closer degree of approximation than can be attained in the observations. We will, therefore, assume in our calculations that equation (5) is sufficiently correct for our purpose.

To find the constant for reducing the indications of a galvanometer to amperes let the instrument be joined in series with a standard galvanometer, a battery, and such resistance as may suffice to bring the deflection to a convenient amount. Observe that the instruments indicate zero when no current is flowing (it is well, when observing the zero of a high resistance galvanometer, to put a short wire across its terminals in case there should be any thermal or other electromotive force in the coil), then close the circuit, and observe simultaneously the deflection on the two instruments; then reverse the current, and again observe the deflection on the two instruments. Let a be the mean deflection on the standard, and a' that on the instrument being tested. From the standard galvanometer we have for the current C in absolute measure

$$C = \frac{H R^2 \tan. a}{l},$$

and since one ampere is $\frac{1}{10}$ of a C.-G.-S. unit of current, if C_a denote the current in amperes,

$$C_a = \frac{10 H R^2 \tan. a}{l}. \quad . \quad . \quad . \quad . \quad (6)$$

Now, if the value of H is the same for both instruments we have from the galvanometer which is being tested

$$C_a = G H \tan. a',$$

where G is the constant of the galvanometer when placed in a magnetic field of unit intensity.

Therefore, from (6) we have

$$G = \frac{10 R^2}{l} \frac{\tan. a}{\tan. a'}. \quad . \quad . \quad . \quad . \quad . \quad (7)$$

It is assumed here that the galvanometers are placed in a uniform field of force, but it must be remembered that it is difficult to obtain this in most laboratories not specially constructed for electrical experiments. In an ordinary room the force may vary as much as 10 per cent. between two points two or three yards apart, the variation being caused by iron in the structure of the building. We require, therefore, not only the absolute force at the place of the standard galvanometer but we require also the force at the other instrument. The ratio of the forces at the two places may be determined by vibrating a magnet in the way described for determining H, and deducing its value by the equation,

$$\frac{H}{H'} = \frac{T'^2}{T^2},$$

where H and H' are the forces at the places at which the periods are T and T' respectively. The ratio may also be determined by placing a galvanometer first in the one and then in the other position, and observing the deflection produced by the same current in the two cases. In that case we have

$$\frac{H}{H'} = \frac{\tan. a'}{\tan. a}.$$

For an instrument which is to be used always in one position and under the earth's field alone this is all that is necessary. But for many practical purposes the instrument requires to be moved from place to place, and, besides, requires the field of force to be much more intense than that of the earth in order to keep its indications within the range of the scale, and to prevent disturbances from magnets or from iron in the neighbourhood. The field is generally intensified by placing a permanent magnet near the needle in such a manner as to produce at the needle a magnetic field parallel to the plane of the coil. This field magnet is in the best position when the centre of its magnetic axis coincides with the centre of the magnetic axis of the needle. Except in the case of an instrument to be used always in the same position and under the influence of the earth's field alone, it will be found most convenient to know the constant of the coil for a field the intensity of which is unity. When this constant is once known a standard galvanometer is not again required for the adjustment of the constant of the instrument, all that is required being the intensity of the magnetic field in which the needle is placed. The determination of the constant of a galvanometer for unit field does not involve the determination of the absolute intensity of the field either at the place where the standard galvanometer or the one to be tested is placed. The ratio of the intensities at the two places, however, must be known, and hence the desirability of making the tests at a place where the ratio is unity. When this ratio is $\frac{H}{H'}$, equation (7) becomes

$$G = \frac{10 R^2}{l} \cdot \frac{H \tan. a}{H' \tan. a'}. \quad . \quad . \quad . \quad . \quad (9)$$

When the sensibilities of the two instruments are so different as to render the method of comparison here described unsuitable, the instrument which is most sensitive may be shunted by a known resistance. Should the instrument to be shunted have a very small resistance it may be advisable to add some resistance external to it. This resistance is to be treated as part of the coil when shunting the instrument. Let C_a and C'_a be the current flowing through the unshunted and shunted instruments respec-

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tively, R_1 the resistance of the coil and added resistance and R_2 the resistance of the shunt, then

$$C_a = C'_a \frac{R_1 + R_2}{R_2}.$$

A galvanometer, the coil of which has a high resistance, forms a very convenient instrument for the determination of the difference of potential between two points of a circuit. Such an instrument has been called by Sir William Thomson a potential galvanometer. When the instrument is to be used as a potential galvanometer, the constant G requires to be multiplied by the resistance of the coil in ohms, as will appear from the following considerations. We have for the current flowing through the coil

$$C_a = G\,H \tan. a'.$$

and by Ohm's law, if R be the resistance of the coil in ohms, and E the difference of potential between its ends in volts,

$$E = C_a' R = G\,R\,H \tan. a'.$$

Hence, if G_v be the co-efficient for volts,

$$G_v = G\,R.$$

The methods of determining the co-efficient for volts are the same as those which may be employed for the determination of the co-efficient for amperes, as, for instance, that already described. The mode of joining up the instruments illustrated in Fig. 2 will be convenient for many purposes, especially where potential galvanometers are being tested. The standard galvanometer G is joined in series with a

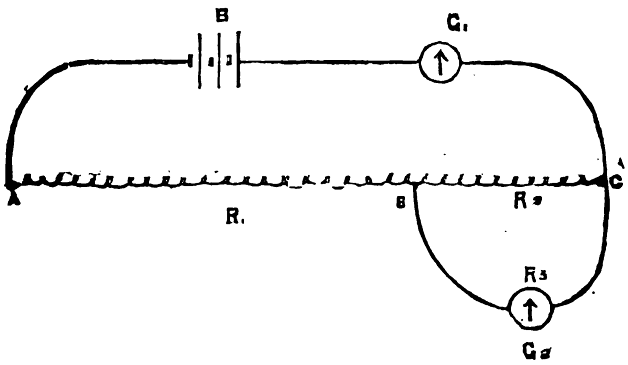

FIG. 2.

battery, B, and a resistance, $R_1 + R_2$, while the galvanometer G_2 is joined to the points B and C, so as to form a shunt on the resistance R_2. The battery B and the resistance R_1 and R_2 are to be adjusted to give a convenient deflection on G_1. It may be remarked that the best deflection is 45°, this being the deflection which gives the least error due to a given constant error in the observation of the deflection. If a be the deflection due to any current, and $\delta\,a$ the probable error of observation, the percentage error in the estimation of the current is proportional to

$$\frac{\tan.(a + \delta\,a) - \tan.a}{\tan.a},$$

or nearly to

$$\frac{\delta\,a\,(1 - \tan.^2 a)}{\tan.a\,(1 + \tan.^2 a\,\delta\,a)},$$

which is zero when a is 45°. Let C_a be the current in amperes flowing through the galvanometer G_1, then the current flowing through G_2 is $C_a \frac{R_2}{R_2 + R_3}$, and hence we have

$$C_a \frac{R_2}{R_2 + R_3} = G\,H \tan. a',$$

or

$$G = \frac{C_a R_2}{(R_2 + R_3)\,H \tan. a'} = \text{co-efficient for amperes.}$$

The co-efficient for volts is

$$G\,R_3 = \frac{C_a R_2 R_3}{(R_2 + R_3)\,H \tan. a}.$$

Now, if R_3 be great compared with R_2, this equation may be written $G_v = \frac{C_a R_2}{H \tan. a}$, that is to say, the difference of potential between B and C may be taken to be the same as if the circuit of G_2 were broken. When R_2 is less than $\frac{1}{1000}$ of R_3, this method is convenient and sufficiently accurate.

Next let us consider how the intensity of the magnetic field produced by a permanent magnet may be determined. Suppose an arrangement similar to that in Fig. 2 to be made, omitting the standard galvanometer G_1, let the resistance between B and C be adjusted so as to give a convenient deflection on G_2, when the earth's magnetic field alone is used, and again, when the magnet is placed in position on the instrument. Let the resistances in the two cases be R_1 and R_2, and let R_3 be the resistance of the galvanometer, R the total resistance in the battery circuit when the galvanometer circuit is broken, and E the E.M.F. of the battery. The current through the galvanometer in the first case will be

$$\frac{E\,R_1}{(R - R_1)\,(R_1 + R_3) + R_1 R_3},$$

and in the second case

$$\frac{E\,R_2}{(R - R_2)\,(R_2 + R_3) + R_2 R_3}.$$

Let the intensities of the magnetic field be H and H′, and let the deflections be a and a' in the two cases, then

$$\frac{H \tan. a}{H' \tan. a'} = \frac{R_1\{(R - R_2)\,(R_2 + R_3) + R_2 R_3\}}{R_2\{(R - R_1)\,(R_1 + R_3) + R_1 R_3\}},$$

and therefore

$$H' = \frac{H \tan. a}{\tan. a'} \times \frac{R_2\{(R - R_1)\,(R_1 + R_3) + R_1 R_3\}}{R_1\{(R - R_2)\,(R_2 + R_3) + R_2 R_3\}}. \quad (10)$$

When the resistance of the galvanometer is great compared with the resistance of the battery, or when its sensibility is sufficient to allow resistance to be added to its circuit, the formula can be simplified by neglecting the battery resistance, and making $R_2 = R$, we then have the potential between A and C equal to the full potential of the battery, or

$$E = G_v\,H' \tan. a',$$

and the potential between B and C

$$E_1 = G_v\,H \tan. a = \frac{E\,R_1}{R + R_1}.$$

Substituting for E, we get

$$G_v\,H \tan. a = \frac{R_1}{R + R_1} G_v\,H' \tan. a',$$

$$\therefore H' = \frac{H \tan. a}{\tan. a'} \cdot \frac{R + R_1}{R_1}. \quad (11)$$

It must be remembered that H′ represents the sum of the intensities of the fields produced by the earth and the magnet, and hence, that if H_m be the intensity of the field produced by the magnet alone, then $H_m = H' - H$, and, therefore

$$H_m = H \frac{R \tan. a + R_1 (\tan. a - \tan. a')}{R_1 \tan. a'}. \quad (12)$$

A similar equation for H_m may be deduced from equation (10), but it is generally simpler to use equations (10) and (11) and subtract H from the result.

When, as is the case with Thomson's new current and potential galvanometers, the sensibility can be changed without changing the intensity of the field we may adopt the following simple method of comparing the intensity of the field produced by the magnet with that of the earth. Join up the galvanometer in circuit with a battery capable of giving a constant current, and adjust the sensibility of the instrument until a convenient deflection is obtained with the earth's field alone; let a be this deflection. Next place the magnet in position and change the sensibility until a similar deflection is obtained; let a' be this deflection, and let S be

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the ratio of the sensibility in the first to that in the second case, then

$$\frac{\tan.\alpha}{\tan.\alpha'}=\frac{H'}{SH}\text{, and, therefore, }H'=SH\frac{\tan.\alpha}{\tan.\alpha'},$$

or,

$$H_m=H'-H=\frac{SH\tan.\alpha-\tan.\alpha'}{\tan.\alpha'}. \quad . \quad (13)$$

Various modifications of the methods here described will at once suggest themselves, and in the case of the magnet constants several purely magnetic methods might be employed; but it is generally better to determine the constant of the magnet when in position on the galvanometer, and when possible by means of the galvanometer itself.

Graduation by Electrolysis.

The electro-chemical equivalents of most of the metals have been carefully determined and tabulated, and hence we may avoid to a great extent the labour entailed by the method above described by taking advantage of these tables of equivalents. The following brief indication of the mode of proceeding to take advantage of these tables will probably be sufficient for most purposes, but much useful information on the mode of obtaining good deposits can be obtained from any good book on electro-plating.

Make up a strong neutral solution of pure copper sulphate and pour it into a suitable vessel to act as a plating bath; an ordinary beaker will generally do. Cut two plates for electrodes out of thin sheet copper of such a size that the density of the current between them will be about $\frac{1}{50}$ of an ampere or less; that is to say, the area of the plate in square centimetres should be about 50 times the number of amperes of current in the circuit. Clean the plates carefully by polishing and washing first with acidulated and then with clean water. Put some distinguishing mark on them, and then weigh them accurately on a sensitive balance. Place them in the liquid, with their planes parallel and facing each other, at a distance of about one or two centimetres apart, and join up this cell in series with the galvanometer to be tested and a battery equal to about two or three Daniell's elements. Observe the time when the circuit is closed, and take care that it is not broken or reversed during the experiment. Take a reading of the galvanometer deflection, say half a minute after the circuit is closed, and then at regular intervals during the experiment. If the current is nearly constant the intervals between the readings may be several minutes, but if it is variable frequent readings must be taken. The current should be allowed to flow for such a length of time that the copper deposited can be accurately weighed with the balance at disposal, it may extend from fifteen minutes to an hour or more according to the strength of the current and the sensibility of the balance. Note the time when the circuit is broken, and then remove the plates carefully from the solution, and wash the one on which the copper has been deposited in clean water. Great care has to be taken, especially when the amount of copper deposited is small, to avoid error due to imperfect washing or drying of the plate, and also that none of the deposited copper is removed in the operation. The water in which the plate is washed, as well as the solution, should be carefully examined for metallic copper, and if any is found the experiment should be repeated. Weigh the plate and subtract the weight which it had at the beginning of the experiment, the difference is the weight of copper deposited. From this we obtain the value of the galvanometer constant in the following manner:—One coulomb of electricity deposits very nearly ·00326 of a gramme of copper from a solution of sulphate of copper; hence the number of grammes deposited, divided by ·00326, gives the number of coulombs, while this number, divided by the time in seconds that the current was flowing, gives the mean current in amperes. That is, if w be weight of copper deposited, and t the time in seconds,

$$C_a=\frac{w}{t}\,\frac{1}{\cdot 00326}.$$

Now, assuming as before that we are using a tangent galvanometer, we may find the mean tangent of the deflection by finding the sum of the means of the tangents of each successive pair of readings multiplied by the interval between them, and dividing the result by the total time that the current flowed; or we may make the time and tangents of deflections abscissæ and ordinates of a curve, and find the area enclosed by the curve, and the axes of co-ordinates by any of the approximate methods employed for that purpose. Let the mean tangent so found be denoted by tan. α, and we have the equation

$$C_a=G\tan.\alpha$$

for the determination of G, the co-efficient for amperes of the instrument in the actual magnetic field employed during the experiment. If the co-efficient for volts be required it may be obtained from this by multiplying by the resistance of the galvanometer.

When determining galvanometer constants by this method it is important that the whole current passing through the circuit be sent through the electrolytic cell, as polarisation prevents any method in which shunts are used from being reliable. It may be remarked also that this method is not very well adapted for high resistance galvanometers unless they be sufficiently sensitive to admit of their being strongly shunted during the experiment, because of the feeble current which can be sent through such instruments. If a high resistance galvanometer be tested by shunting it so as to lower the resistance in the circuit care must be taken that the resistance of the shunt is not changed by heating during the experiment.

ANTOINE BREGUET.

Our contemporary, *La Nature*, announces the death, from heart disease, on the 8th inst., of M. Antoine Breguet, well known in electrical circles in Paris. M. Breguet was only 32 years old when he died, having been born in Paris on the 26th January, 1851. To complete his education he entered the Polytechnic School in 1872, and on leaving this at once entered the firm of Breguet as electrical engineer.

During this period (says our contemporary) he published essays on telephony and electrical machines. He made one notable contribution to the *Annales de Chimie et de Physique* on the theory of the Gramme machine, an essay which was marked by great simplicity and replete with original ideas. At the end of 1877 Antoine Breguet married. A little later, in 1880, he accepted the management of the *Révue Scientifique*, in common with his friend, M. Richet, an able physiologist and writer.

In 1881 Antoine Breguet took an important part in the organisation of the Electric Exhibition, as head of the department for placing and arranging the exhibits. He worked in this capacity with great zeal and activity, and exhibitors invariably found him most willing to oblige. Antoine Breguet, by his intelligent and earnest assistance to M. George Berger, contributed greatly to the success of the Exhibition. It was he who originated the happy idea of establishing telephonic auditoriums at the Palais de L'Industrie in connection with the Opera. He was nominated a delegate to the Congress of Electricians by the management of the Exhibition, and was rewarded for his labours at these two international gatherings by the Cross of Chevalier of the Legion of Honour.

At the beginning of the present year the firm of Breguet was formed into a company, and Antoine Breguet assumed the management, with the title of managing director. Before becoming manager of the *Révue Scientifique* Antoine Breguet was a member of the staff of *La Nature* from the year 1875 to 1878. He leaves a young wife and three children, and friends who sincerely mourn his sudden loss.

Business Notice.—We are informed that the businesses of Mr. W. F. Dennis, also Messrs. W. F. Dennis and A. Dennis, wire merchants, &c., of 101, Leadenhall-street, E.C., hitherto carried on under the style of Dennis and Dennis, will be amalgamated, and will hereafter be carried on under the style of W. F. Dennis and Co.

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ELECTRICITY AND WAR.

That nothing is so certain as the unexpected has once again been demonstrated in the old familiar way. Notwithstanding the telegraph and the guarantees of peace which were supposed to follow in its train, war, for the hundredth time, has contrived to take us by surprise. Probably not one of the civilians who went down to Chatham the other day to witness the performances of electricity in the interesting pastime of mimic warfare had pictured to himself even the possibility of such things happening in real earnest. Yet at about the self-same hour, when earthworks were being blown up for the amusement of our telegraph engineers, just to show how it could be done should ever occasion arise, similar explosions were rending the air elsewhere, carrying with them skywards the fragments of some hundreds or thousands of hapless mortals who had persisted in the belief that shot and shell are the only arguments worth listening to. That belief is not confined to the Egyptians, and it is fortunate for us all that the military instinct of every nation finds its outlet in foreseeing and providing for contingencies which the civil professions are slow to apprehend. But for the painstaking wisdom of those very officials and their associates who gave us a day's entertainment at one of England's greatest arsenals, England might now have been, not only surprised, but unprepared.

Over and above the telegraph, electricity has of late years played an important part in the operations of war. Some people prefer to say that those deadly ingenuities, the electrical torpedo, electrical mining, electrical volley firing, and the like, all tend to avert war. Certain it is they add to the horrors of war, and if only the enemy would consent to be frightened by them beforehand, undoubtedly there would be no occasion for war. But we have not arrived at that stage yet awhile, and for the present we must be content with at least shortening their duration, though we cannot prevent the outbreak of hostilities.

That we cannot by any yet known mode of reasoning, or any sufficiently overmastering form of armament, prevent war, is made plain to us with ever painful recurrency, and the lesson we ought to learn from this fact is to be always prepared for it. By being prepared for it in this relation we, of course, mean being well provided for it. We observe, therefore, with much satisfaction, that our fleet before Alexandria is amply equipped with electric lighting appliances. This means that during the last interval of peace our naval authorities have instituted and perfected experimental electric lighting to a degree enabling them to utilise it promptly and efficiently when the time came for using it. The time, as sure as ever, did speedily come; and here we have the electric arc piercing the darkness of treacherous night, prying into the stealthy operations of the foe on land, and keeping off all sinister movements by water. It would appear, also, that it has been used for signalling purposes, and it is obvious how readily this may be done at distances many times greater than those it was required to penetrate before the doomed city of Alexandria. A dot and dash message might, we imagine, be read far beyond mast-head level, if flashed upwards instead of horizontally. All this speaks well for the electric light as an adjunct of war, but it also reflects the highest credit on the wisdom of our naval and military authorities.

Of the immense service rendered us by the cable operations at this juncture we need hardly add one word to what has already been freely confessed by the daily Press. But we can remember the time when co-operation such as that which just now seems so natural would have been all but impracticable. Now we hear of the fleet admiral "ordering" the telegraph ship nearer in shore. Not so many years ago the chances are he would have "ordered it off." Perhaps in his heart he wishes it was far away, and that Downing-street were not made quite so near; but if personal responsibility is no longer to prevail in the leaders of our armies and our navies, the closer they can be brought to the men who are responsible, the better, obviously, for all parties.

In spite, however, of the general excellency of the arrangements, and our certainty that all was done that science had yet enabled us to do, one little shortcoming could hardly fail to be noticed in the events of last Tuesday week. The "Chiltern" cable ship was but a comparatively short distance from the fighting ships, yet communication was difficult and slow—occupying, it would seem, as long a time as to bridge over the 2,000 miles separating her from London. This is not as it should be; and the most pressing invention needed for naval warfare is a ready means of electrically telegraphing between ship and ship. The discovery made by an officer of the Royal Engineers some time ago naturally recurs to us in this connection. He found that by means of the telephone, signalling with a Morse key could be very well heard, though the conducting wire was severed and far apart,

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when the ground was wet, or the ends were in a river. Mr. McEvoy's application of Professor Hughes's induction balance principle to the detection of submarine torpedoes has also a bearing on this desideratum. Even dismissing these perhaps too speculative hints, and coming to safer ground, we cannot help thinking that what the military telegraph corps has done for its department might conceivably be done for the navy. A floating drum bearing a light cable is not, one would imagine, an impossible device, especially to any one who has seen silk unwound from a cocoon in water. The cocoon, it is true, has but one end free; but to the heroic inventor this is a mere detail.

Speaking of light cables we are reminded how useful would have been even a temporary means of communication of that sort along the Suez Canal at this moment. The high road to India is what we are at present—if we except Ireland—most concerned with, and yet when the admiral of our fleet had greatest need of knowing the condition of that route, a gap of some 150 miles intervened between him and it, and even then he had no means of ascertaining what might be going on in the midst of it or at the other end. But here, probab ly statesmen, and not the officials we have been commending, are the people in fault. The establishment of telegraphic communication along a marvellous but somewhat ticklish maritime pathway is greatly to be desired, and possibly this fact may be brought home convincingly by our present troubles in Egypt, as was the much-needed cable to South Africa by hostilities in that quarter.

THE CRYSTAL PALACE EXHIBITION.

Post Office Exhibits.

(CONTINUED FROM PAGE 199.)

Last week an unfortunate error occurred in Fig. 11. The wire connecting zinc to the left hand relay should have been joined to line only. In Fig. 12, also, the draughtsman has represented a hand working the key on the right, whereas only the key on the left side of the diagram is supposed to be working.

By winding the bobbins of the polarised relay with two sets of wires, as already described, duplex transmission becomes practicable on long lines. Instead of the batteries being joined up, as in the preceding illustration, they may have like poles to earth and to the key. In this case each station would receive a signal during the simultaneous depression of the keys, in consequence of the antagonistic electric forces in the real line reducing the electro-magnetic effects of that branch to insignificance, while another portion of the current from the home battery acts vigorously upon the artificial line R. As duplex telegraphy can be maintained whether the distant batteries assist or oppose each other, the method becomes applicable to the double current system previously noticed. Fig. 14 displays a complete double current duplex sounder set of apparatus as adopted by the Post Office. A is the key, B relay, C galvanometer, D sounder, E rheostat, F condenser, and G switch. The condenser contains sheets of tin foil and paraffined paper alternately separated. The tin foil sheets are divided into two groups, and connected up, as seen in Fig. 15, where the spaces between the lines represent paraffined paper. Without a condenser in-

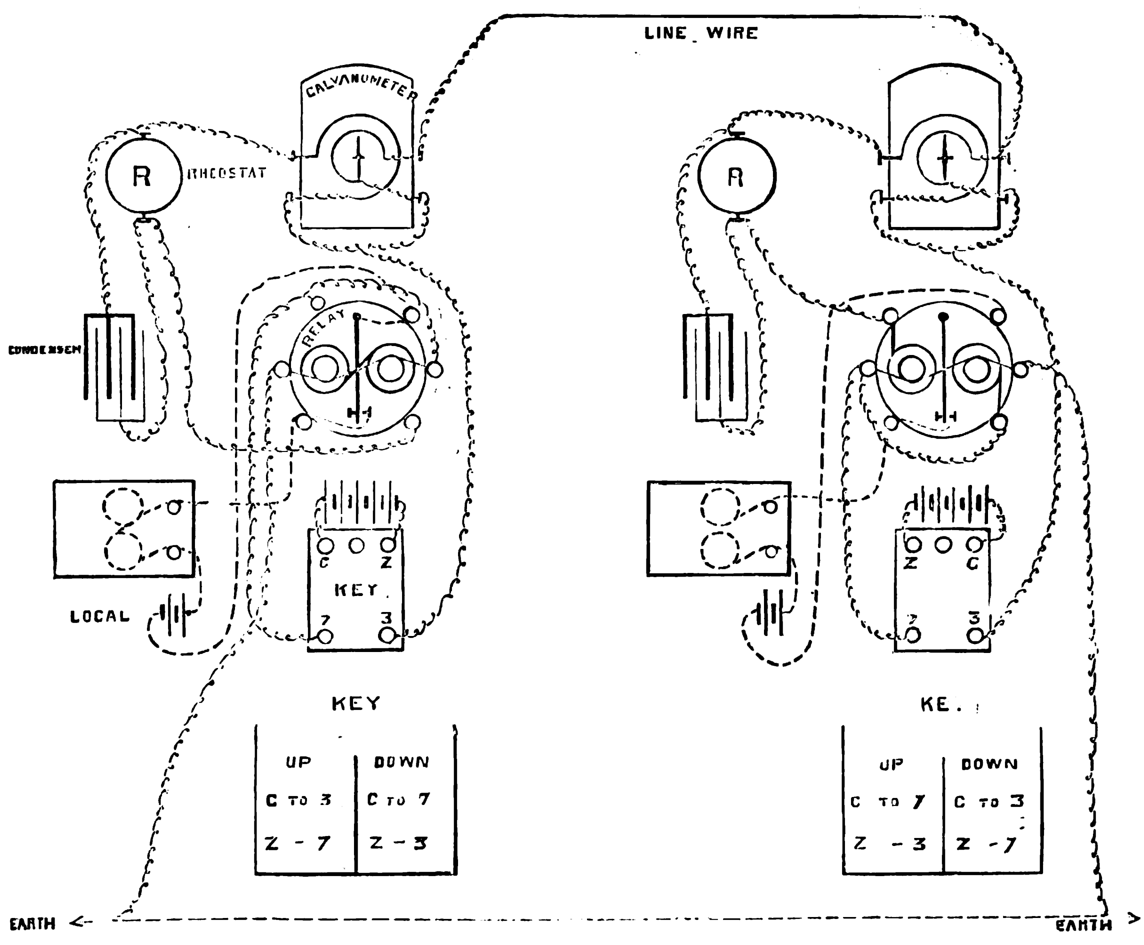


FIG. 15.—Plan of Double Current Duplex Circuit.

terruptions would occur while receiving, due to the back rush of electricity from the line wire through the relay; but by causing the electrostatic induction of the condenser to equal that on the line, the opposing and simultaneous discharge from both keeps the balance of relay perfect, and thus avoids interference. Some of the brass pegs represented in F, Fig. 14, enable the operator to vary the electrostatic capacity of the condenser according to the state of the line. The arm of switch G makes the system simplex or duplex. The galvanometer C is wound differentially, like the relay, *i.e.*, two lengths of wire having the same resistance. This facilitates easy balancing of relay by adjusting the rheostat as the key is actuated, until the needle remains motionless. Fig. 15 is one example of a double current duplex circuit.

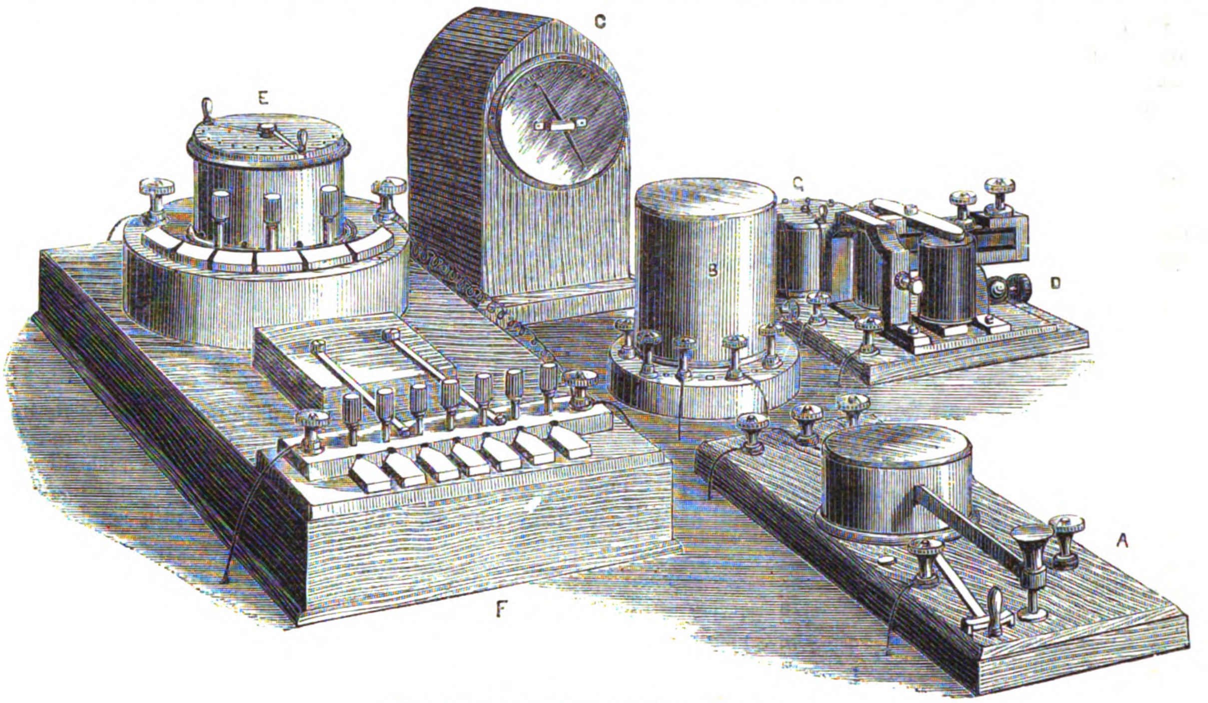
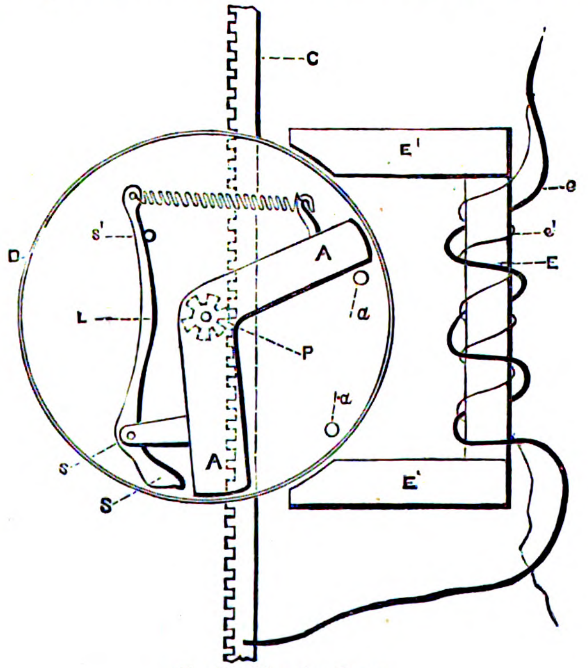


Fig. 14.—Double Current Duplex Sounder.

(TO BE CONTINUED.)

THE DIAMOND ARC LAMP.

This lamp, which is now being exhibited at 374, Euston-road, is made from the design of Mr. C. D. Haskins, of New York, a gentleman well known in electrical circles not only in America but also on this side the Atlantic. As in most of the modern lamps, the upper carbon descends by gravity, its motion being controlled by an electro-magnet. The accompanying diagram shows the mechanism of the lamp. The upper carbon holder is attached to the rack C. This rack gears into a pinion, P, fastened to the centre of the disc D, which disc rotates by the descent of the carbon. Instead of the rack and pinion, which are preferred, a cord and pulley or other equivalent arrangement may be used. To control the downward movement of the carbon holder a brake is applied to the rim of the disc, and as the disc may be of a fairly large size the power requisite to check its motion and resist the weight of the carbon holder may be very small. The brake is shown in the figure at the foot S of the bent lever L, pivoted at *s* on an arm of the armature A A.



The Haskins Arc Lamp.

This armature is pivoted at the centre of the disc D, about which it freely swings under the action of the varying actions of the poles E′ E′ of the electro-magnet E. The core of E is wound with two coils of wire, the priminary *e* of thick wire traversed by the main current, and a secondary *e*′ of fine wire to act as a shunt.

When the carbons are together before starting the light the greater part of the current goes through coil *e*. The armature A A is attracted, carrying with it the brake S, which clamps against the rim of the disc D. Any further motion of the armature then turns the disc and raises the upper carbon establishing the arc. When the main coil current weakens by the lengthening of the arc, the armature swings away from the magnet by the action of gravity, and in doing so lowers the carbon to a slight extent. When it reaches the position in which the upper end of the lever L bears against the pin *s*′, the brake S is released and the carbon is free to slide downward. These movements under normal conditions are small, the parts being so arranged as just to allow the carbon to descend at the proper rate. The lamp is said to adjust itself to the current, and to burn well with either a weak or a strong current, in the one case the carbons being closer together, and being, therefore, a shorter arc than in the other case. It will be seen that the parts of this lamp are few, and thus it offers the great advantage of simplicity. When we saw the lamp is was burning steadily.

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CORRESPONDENCE.

DYNAMO MACHINES AND HELICAL FORCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you allow me to call attention to the errors and confusion of the article on dynamo machines, &c., in your last issue, on page 176. And, first, I would like to know what kind of machine is the "Saxton Commutator," and when was it patented? By the "Gramme Commutator" the writer, no doubt, means the Gramme dividing machine—but why doesn't he say so? Again, he puts the Siemens as a direct descendant of the Gramme, and the Brush he inserts twice over. As for the rest, it is scarcely necessary to do more than point out that he—or the engraver—is unable even to spell the names of four of the few other machines he thinks fit to mention.

It is a pleasure to turn from these laboured articles to the fresh and fascinating subject treated so eloquently by Dr. Shettle on pages 181, 182, and 183, the ever fruitful theme, "What is Electricity? Temperature." Many times have I been struck with the action of helical forces in nature, but never more powerfully than by the beautiful and lucid illustration of the blind cords in article X. The quadrillions of tons of force screwing themselves down from the sun upon the earth, and then being discharged up again from the poles as a mighty reaction, and the evolution of the laws of motion through the helical vortices generated when the sun's helical force gets entangled in the earth's helical reaction, as developed in sections 17 to 20, form a conception never equalled since the publication of the "Principia."

The universality of the action of helical forces and the vortices produced by helical reaction may be illustrated in so many striking ways that I may be pardoned for suggesting one that I noticed at a restaurant the other day, where by an application of helical force a liquor was extracted from a glass vessel which could not possibly have been extracted in any other way, and the helical reaction lying dormant in the liquid was not yet discharged (this was the important observation) till it had entered a living organism. But, sir, a still more astounding discovery has rewarded me since then. I have discovered a liquor whose helical reaction is so great that it can extract its own cork. No external helical appliances are necessary; in fact, it exerts a negative helical force itself, and wires have to restrain it—wires which conduct electricity. The liquor is expensive, and, I believe, is a monopoly of a Mr. Heidseick, but if he or any of your correspondents would send me some to try I should be able to investigate whether the latent and organically developed portion of the helical reaction is as great as I venture to predict it will be.—Yours, &c.

CHARLES JONES.

Science Chambers, Upper Holloway.

[The engraver was guilty of the errors which appeared in the table adversely criticised by our correspondent, mistaking, or rather unheeding, his instructions not to finish the block before the drawing was corrected.—Ed. *E.*]

DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to a letter in your publication of the 15th inst., signed "Wonderer," the most likely cause of the trouble is that the lamps are out of adjustment, and that occasionally one or the other breaks arc; a load is consequently taken off the engine, and if driving the dynamos constitutes any considerable proportion of its work, it probably "runs away" more or less with the machine driving the other lamp, the latter brightening up in consequence.

Dynamo machines, however, should never be fastened upon iron bed plates; these should be of wood. The presence of any iron other than parts of the machine itself produces a redistribution of the magnetic field, which will necessarily influence the working of the machine. The sheet asbestos used to avoid actual contact only slightly moderates the effect by removing the iron a little further (probably a very little) away from the machine than it otherwise would be.

If the lamps are in good order and the engine keeps a constant speed, the machines are probably so connected together by the bed plate, or opposing poles—*i.e.*, like poles—of the field magnets so closely, that the magnetic system is in a state of unstable equilibrium. If, then, the current in one machine increases, consequent upon an alteration in the resistance of the arc of the lamp it is driving, the field magnets of that machine are strengthened, and the field magnets of the other machine neutralised to a greater or less extent, and first one machine, then the other, will have the ascendancy.—Yours, &c., W. B. SAYERS.

Chelmsford, July 18, 1882.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I offer a suggestion as to the cause of the trouble that your correspondent "Wonderer" experiences with his dynamos.

I presume that, being small machines, they are both driven by one engine. Well, then, this being the case, any irregularity in the action of one of the lamps would cause an increase or decrease in the resistance of its machine, thus taking some of the load off the engine, or *vice versâ*, which would sensibly affect the speed of the engine, and, consequently, the current in the other dynamo and its lamp.

Why not connect the machines and lamps up in one circuit, and thus equalise both. I shall be glad to know if this succeeds.—Yours, &c., "ACCUMULATOR."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The effect your correspondent, "Wonderer," observes may be due to two causes. If he is driving both dynamos from one engine, should the feeding arrangement of either lamp stick or work sluggishly, or the arc increase so much as to materially reduce the strength of the current, and perhaps temporarily put that lamp out, then the engine being freed from a portion of its load, would, unless it was very carefully governed, increase its speed. The other lamp would thereby receive an increased strength of current, and would probably burn brighter until the other lamp got into working order again, or the engine was reduced to its normal speed.

As, also, his two dynamos are placed very close together, if their position is favourable, the sudden cessation of the current, or even a large decrease in the current strength in one dynamo, may *induce* a powerful current of momentary duration in the other.

Should "Wonderer's" lamps go out from the carbons running together and sticking, the sudden increase in the current strength in one dynamo may also give rise to a momentary induced current in the other.

The position of the dynamos themselves relatively to each other and to their external circuits, will determine whether these induced currents increase or decrease the working current passing through the machines and lamps.

In the case, however, where the carbons of one lamp stick together and become incandescent, we should expect that the additional pull upon the engine would tend to lessen its speed, and so deaden the light given out by the other lamp, in spite of the assistance of the induced currents.

If "Wonderer" has any further difficulties with his apparatus, and will place himself in communication with us, we shall be pleased to help him out with them.—Yours &c.,

SYDNEY F. WALKER AND OLLIVER.

Black Boy Yard, Long Row, Nottingham.

ELECTRIC LIGHTING AND GAS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with considerable interest Mr. Sugg's very able lecture in *The Electrician* of last week on the com-

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parative merits of gas and the electric light, in which he says that gas is much more suitable for large spaces than arc lights, and more steady.

There is an old saying, "seeing is believing," and if Mr. Sugg will, any evening except Saturday, take a walk down Fleet-street, and place his back against the wall opposite the new *Daily Telegraph* offices, he will have an exceptional opportunity of comparing his latest three light patent burners burning within a few yards of a new arc lamp, which will, I think, very much modify his opinion.

The patent arc lamp in front of the new *Daily Telegraph* offices simply drowns his lights, and when I saw the sun lights inside of the offices mentioned put on while the arc lights, Fyfe and Main's, were alight, the electric lights were infinitely more steady than that of the gas.

For large consumers, light for light, electricity is far cheaper than that of gas, to say nothing of the advantages of a pure atmosphere and clean ceilings.—Yours, &c.,

A Believer in the Future of the Electric Light.

July 13, 1882.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I notice in your issue of Saturday last a contribution modestly described as "sufficiently long," which might be succinctly disposed of on the *qui s'excuse s'accuse* theory; but as from time to time gentlemen having a very little acquaintance with subjects rush into "print with delightful archness which arises from ignorance," it may be as well to recognise the gentleman's invitation, and recommend him to further pursue his studies, as in the immediate neighbourhood particularised the enterprising proprietors of the *Daily Telegraph* afford ample opportunity for competitive examination. He has in juxtaposition gas, vigorously aided by his excellent burners, struggling to make itself seen in the presence of an electric lamp on the public highway; while within the offices six sunlights of 216 (36 by 6) are paled into insignificance by two similar lamps to the one named. If "popular prejudice" does not reason it is open to conviction by ocular demonstration. Personal prejudice is quite another matter.

Surely it cannot be considered an argument that, because the House of Commons rejected a crude electric lamp in favour of gas, and because a provincial paper avers that an assembly listening to a "Grand Concert" could not discover where daylight ended and gaslight was introduced, that his case is made out, although he seems so self satisfied as to say, "Sufficient for me in this paper to feel that I have proved that gas is steadier and readier and more useful for the purpose of lighting large interior and exterior space than electricity."

When a comparison can be instituted between some of the modern electric lamps and gas with even the best of burners I shall beforehand make bold to say that the result of the Fleet-street demonstration will be considerably amplified.

To refer to the purity of the atmosphere in connection with electricity is mere begging the question. Safety can be disposed of by various theatre experiences, and the Paris catastrophe of yesterday. Facts speak volumes!

In the matter of cost, when the gas companies decree to give their illuminating power gratis, and rest content with the handsome profits on products, even then, after the first outlay is overcome, will electric lighting be recognised and generally adopted?

Instead of employing a dubious vulgarism, "There is nothing like leather," if the gentleman had frankly written "There is nothing like gas and Sugg's burners," he would have been appreciated for manly candour.—Yours, &c.,

July 12, 1882 A Believer in Electricity.

WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In my letter to you of the 26th June I endeavoured to keep Mr. Harbord to the point in dispute by asking him to produce certain information which, if he did not give, I would not answer another letter of his. He has again written to you without giving the desiderated information, therefore I would not have replied but for his having attempted to deprive me of the originality of my experiments with the Leyden jar, published in your columns. I call on Mr. Harbord to quote the passage of Sir William Watson's writings, and give the volume and page where they are to be found.

As to the question of electricity being or not being matter, I would as soon think of speaking to the moon as to correspond with Mr. Harbord about electricity being matter until the preliminary and fundamental question is settled—namely, Is that which some men have called "static electricity" divisable into two electricities, or, to use Mr. Harbord's words, Is the *force* decomposable and recomposable? Until this (the first step in the process) has been proved it would be madness to attempt to discuss with Mr. Harbord the question as to whether electricity is or is not matter. I have in your columns produced experimental proof that there is only one electricity. No man has been able to rebut the evidence I have given on this subject. On the other hand, Mr. Harbord has again and again written to the effect that electricity is divisible or can be "decomposed and recomposed." I challenge him to produce proof that that which some men call "static electricity" is divisible into two kinds, or is a force that is decomposable and recomposable. Until the foregoing fundamental point is forced home on Mr. Harbord's mind it is impossible for him to understand the question as to whether electricity is or is not matter.

In Mr. Harbord's last letter, p. 184, he asserts that I have "said" that "there is no such thing as magnetic repulsion." He places these words in quotation marks as if I had used them, and charges me with ignorance for having done so. I have neither said nor written that there is no such thing as "magnetic repulsion." It is a wrong statement of Mr. Harbord's, and shows the worthlessness of his writings in a scientific point of view; for true science is professedly a search to obtain truth.

Let me here note that the point I have endeavoured to keep Mr. Harbord to is exactly the point I endeavoured to bring Dr. Shettle to—namely, that he has founded his theory of electricity on the assumption that the so-called "static electricity" is divisible into two forces. Although Dr. Shettle were to write letters in *The Electrician* till the day of his death, as far as the nature of electricity is concerned all his writings will be valueless, because all his statements about the nature of electricity are founded on the false assumption of "static electricity" being of a compound nature, and of this he has given no proof. I have given proof that there is only one electricity, and Dr. Shettle has not attempted to show that my proof is wrong.—Yours, &c.,

James Johnstone.

Experiment Rooms, 1, James-square, Edinburgh,
July 10, 1882.

NOTATION AND NOMENCLATURE.

TO THE EDITOR OF THE ELECTRICIAN.

(Translation.)

Sir: In your leading article of the 19th inst. you rightly demand uniformity of notation and nomenclature, but as you have honoured me by quoting the English translation of my book permit me to make an observation on this subject.

The adoption of the letter I as indicative of the intensity of the current (what is called *current* in English) has the advantage of avoiding all confusion, such as you call attention to a few lines further down as existing "in a book used by students preparing for the London University examination," for the notation of the five electrical quantities can then be indicated as follows:—Intensity (current), I; electromotive force, E; resistance, R; quantity, Q; capacity, C.

As to the preference which you appear to give to foot-pounds in place of centimetre-grammes, it seems to me to be the less justified in that the electrical units almost uni-

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versally adopted at the present time are based on the C.-G.-S. system.

The article of Mr. Samuel Phillips which you print immediately after your leading article only still more increases the confusion against which you are combating, since the practical units which the author extols so highly are a mixture of metrical, C.-G.-S., and English units, in a word, a mixture which is neither flesh nor fish, equally unqualified to satisfy *savants* and practical men, since these units are not based on any co-ordination, and are absolutely independent of one another.—Accept, &c., E. HOSPITALIER.

23, Rue D'Arcole, Paris, 16th July, 1882.

THE ELECTRIC LIGHTING BILL.

Below we give a report of the debate on this Bill, which took place in the House of Commons on Saturday last, as it appeared in *The Observer* of the 16th instant:—

On the order of the day for going into Committee upon this Bill,

Colonel MAKINS said that when the question of holding a Saturday sitting was discussed on Thursday night he intimated that he would not move the amendment of which he had given notice until the third reading, but he had since consulted with the President of the Board of Trade, who thought it would be better to take the discussion to-day. Although it was well known that he was connected with gas companies, he did not appear there as the representative of those interests as opposed to the present measure. On the contrary, the gas companies, as far as he was able to gather, were satisfied with the general scope of the measure, and, indeed, regarded it as a very strong and a very essential effort on behalf of the Board of Trade to grapple with a very difficult question. But, although the gas companies were not in any way opposed to the Bill in its general details, yet there were one or two matters of principle which, apart from that interest, he deemed it desirable to call the attention of the House to. In the first place, in regard to the question of electric lighting, it was not the case that any Bill the House could pass would have any effect upon the competition which naturally must arise between various systems of lighting. The results of that competition must, in the end, depend on efficiency and economy; and, although regulations might be valuable in the interests of the public, he did not see how in any way they could affect the interests of the gas companies, who could well afford to look on as to what was going on in the world in reference to electric lighting. They had had forty years' start, and in the course of that period an enormous amount of capital had been provided under the sanction of Parliament, and expended in gas lighting in every part of the kingdom. During the last few years electric lighting, a novel mode of illumination, had made great progress. That progress he ventured to think had been more scientific than practical, but no doubt it had made even practical advance, and the exhibitions at Paris and the Crystal Palace had demonstrated its valuable qualities. Within the last few weeks fifty-five companies had been registered, dealing with the question of electric lighting, and the aggregate capital approached, or even exceeded, the £13,000,000 or £14,000,000 expended during the last forty years in gas lighting. Although he should be the last person in the world to grudge the scientific men who had been engaged an adequate reward for their labours, he thought at the same time that it would be patent to the House that a considerable portion of this capital was not likely to prove remunerative except to the individuals to whom he had referred. Two points which he desired to put before the House were, first, the power taken by the Board of Trade to grant licenses to corporations and companies; and, secondly, the fact that the local authorities were to be entrusted with the powers contained in the Bill, and might plunge into large expenditure for purely experimental and speculative purposes, without being under the necessity of obtaining the assent of the ratepayers. As to the first point, the power asked for by the Board of Trade had hitherto been exercised by Parliament in the shape of provisional orders, and it was an entirely new departure for one of the departments of the State to usurp to itself the powers of the Legislature in matters of this kind. There was also, in his opinion, something quite new in the definition given by this Bill to the term "public lighting," for it had been made to include not only the lighting of streets and thoroughfares, but also vestry halls, churches, and theatres. Beyond this, power was taken to supply the electric light to private consumers, without, as had hitherto been the usage, previous acquisition of the existing sources of supply. As to the power to local authorities to use the money of the ratepayers in the supply of electric lighting without obtaining their consent, he strongly objected to what would be the means of creating within such bodies a sort of bureaucracy which would have an almost unlimited authority over the public purse. He therefore moved "That it is undesirable to retain in the Bill the novel powers proposed to be given to the Board of Trade to grant licenses to local authorities or persons enabling them to exercise power hitherto only granted by Act of Parliament or provisional order confirmed by Act of Parliament; and the power given to local authorities under Clauses 5 and 6 and other parts of the Bill to raise money on the credit of local rates without the consent of the ratepayers, for the purpose of competing with private capital, are contrary to every principle hitherto recognised by the Legislature, and that no Bill containing such powers will be acceptable to this House."

Mr. CARBUTT was glad the hon. and gallant gentleman had opposed what he (Mr. Carbutt) regarded as quite a new departure in legislation, the principle of which, if carried out, would probably hereafter be applied to railway property, and entail by the arbitrary mode of purchase now proposed enormous loss on the present shareholders. The Bill was a violation of all the principles of political economy, and if the purchase clause was carried out, would be a violation of the principle of fair dealing. The proposition was that the public would like a new mode of lighting developed if it could be developed; but the public were not sure, and public bodies would probably not risk the ratepayers' money in experiments. They therefore said, let this be done by private persons, and if they failed there would be no obligation on public bodies to buy, but if they succeeded the public bodies should be entitled to buy at the value of old material. Moreover, the option to buy was not to be given once for all, but was to be recurrent, so that the moment the undertakers who took the first risk began to make a profit they would be despoiled. He protested against the adoption of such a principle in legislation upon these matters.

Mr. SLAGG contended that as electric science was at the present time in a purely experimental condition, it was not possible to fix the value of the undertakings that might be purchased under the Bill, and he asked why outside companies should be encouraged to come in and make enormous profits out of public communities without some power being given to the local authorities such as was provided by this Bill.

Mr. W. FOWLER protested against the proposal in the Bill to give corporations the right to buy up an electric lighting company after fifteen years, seeing they had given tramway companies under the Tramways Act twenty-one years. They ought to give electric lighting companies at least as long as they had given tramway companies. They seemed to be going from one extreme to the other. They gave gas companies too much, and now they were giving electric companies too little. He quite admitted that people were wild about electric lighting, but what they advanced their money for was not for the transaction of regular business, but for speculation, in the hopes of selling their shares at some gigantic profit. He noticed the other day that the £4 paid shares of the Brush Company were worth £28. This was a very demoralising price [laughter]. He was afraid if they did not take care they would discourage people from laying out their money. They held out the prospect to them of heads I win, tails you lose, as the corporations could not lose [laughter]. His strong conviction was that Parliament was going too far in the way of protecting local corporations and discouraging private enterprise.

Mr. STANHOPE thought the discussion on the points which had been raised would be much more advatageous if conducted in committee.

Mr. CHAMBERLAIN regarded the matters that had been raised by the hon. member for South Essex (Colonel Makins) as of considerable importance. If his amendment were carried it would strike one of the principal clauses of the Bill, and might be considered almost as fatal. The questions which had been raised by the members for Manchester and Cambridge were really questions of detail as to the precise nature of the purchase clauses inserted in the Bill, which would be much more conveniently discussed in committee. This question had been fully considered by a committee upstairs. All these powerful interests were represented by counsel, a great number of meetings were held, everything that could be said on the subject was carefully listened to, and, he was glad to say, that upon all the important matters which they had to decide, the committee was practically unanimous. He quite admitted that the proposal of the Bill to grant a license was a novel power, but it followed out the recommendation which was made by a very strong committee which sat on the subject in 1870, of which the present chairman of committees was chairman. Electricity was entirely in an experimental state at present, and the object of the Government in introducing this Bill and the object of the committee he was sure

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had been to give every facility for experimental processess in connection with electricity. If they proceeded by way of provisional order, with the probability that such provisional orders might in every case be opposed by the great vested interests which existed, and which were, to a certain extent, hostile to the new illuminant, they would put inventors and others, consumers desirous of having this light introduced, at such a great disadvantage in consequence of the enormous cost of obtaining powers that they would materially interfere with the progress of this new science; and, therefore, it was thought desirable to introduce some new method by which the experimental stage might be conducted with less expense. The proposal was this—that where a local authority which happened to represent fully the wishes of the district was aggrieved in the application, then the Board of Trade, after hearing all parties who desired to make any objection or representation on this subject, might grant a license, of course for the experiment for the limited period of five years, and he certainly thought that that would be an extremely convenient proceeding, and one that he hoped the House would be willing to adopt. As to the new distinction which the hon. member said had been created between lighting for public and private purposes, that was not really a question of any importance. The greater covered the less in this matter. The second part of the hon. member's resolution went on to protest against what he called the new power to borrow or raise money on rates in competition with private capital, and without the consent of the ratepayers. That raised two important and separate questions. The first was whether such raising of public money was justifiable in competition with private capital.

Colonel MAKINS: Raised under an Act of Parliament.

Mr. CHAMBERLAIN: Under an Act of Parliament or otherwise; but the second point was whether such power should be granted without the consent of the ratepayers. The first question, it seemed to him, was raised in the interests of gas companies and others who fancied they had got a vested interest in lighting, and desired to prevent any competition; and the second question was raised in the supposed interest of the ratepayers. In regard to the first question, it was a mistake to assert that Parliament had only given power to public authorities to raise and expend money in competition with private capital. There were the cases of tramways, baths, and washhouses, and gas itself, most of the corporations having power not merely to supply gas, which itself comes into competition with other forms of illumination, such as paraffin oil, but also in the majority of cases to supply fittings to houses in competition with private undertakings. This competition proceeded on the assumption—which he ventured to think was entirely without foundation—that gas companies, or other companies having at the present time authority to supply gas, had obtained from Parliament authority to supply light. In his opinion, gas companies or corporations having powers to supply gas had obtained no right whatever to be protected by Parliament against the introduction of any new illuminant. If that was the case, it appeared to him to be incorrect to speak of the new illuminant as coming into competition with private capital, and the House would be perfectly justified in giving the powers sought for to local authorities. Then there came the second question, whether these local authorities should exercise these powers without what the hon. member called the consent of the ratepayers; and he appealed to the Borough Funds Act, under which corporations were at the present time compelled, if they desired that their expenses should be borne by the rates, to appeal to the ratepayers before applying for any new Act of Parliament, or opposing an Act of Parliament applied for by any one else. He altogether denied the statement of the hon. member that it worked well. In the opinion of those who he (Mr. Chamberlain) thought were best qualified to judge, on the contrary, there was no provision in the Municipal Acts which was more resented, and, in his opinion, more properly resented by corporations than this. If the corporations were really representative of the interests of the ratepayers, then he said they were bound to trust them wholly, and it was an unconstitutional proceeding to submit all their opinions and decisions to a meeting of ratepayers. The effect of this was bad in more ways than one. It undoubtedly did lessen the efficiency and authority of corporations, but it also tended to degrade them in their own eyes, and to lessen their responsibility and their usefulness, and he hoped to see the time when this Act will be repealed, or, at all events, amended. Although this Bill did not give an appeal to the ratepayers, yet it provided before any license or provisional order was granted that all persons interested should be heard by the Board of Trade. The objections of ratepayers, therefore, would undoubtedly be attended to as they were now in the provisional orders applied for and granted by the Local Government Board for a great number of purposes. This system had given universal satisfaction. It had worked admirably, saved the time of Parliament, and saved the money of the ratepayers. It was that system and no more that this Bill proposed to somewhat further develop. The amendment of the hon. member for South Essex would have a distinct tendency to prevent the general adoption of electric lighting. With these observations he left the matter in the hands of the House.

Mr. WARTON thought that in this Bill the interests of one class had been overlooked—he referred to the inventors—and he believed that their efforts would be hampered by the proposals advocated by the President of the Board of Trade. Their patents were their license, and they wanted none from the Board of Trade. He strongly urged that the interests of this class ought to be respected. Without offence to the right hon. gentleman, he might be permitted to say that the Board of Trade did not content itself with its own business, but showed the tendency to encroach on the duties of other departments. It had taken away from the Trinity House the management of lighthouses, and, if he might use the expression, it had stolen from the Admiralty certain duties connected with foreshore. No doubt this was all very natural, and that was the reason why they had been called down to the House on a Saturday to discuss a Bill which might, under different circumstances, have taken its chance with others in the ordinary way. His feeling with regard to the Board of Trade as a body was that it possessed no scientific claims whatever, and he regarded the adoption of the bureaucratic, or French principle of leaving everything to the department and its highly intelligent President as unsatisfactory, if not unconstitutional. Not only did he advocate freedom for inventors, but he urged freedom for the electric companies to make their own way in the world as other companies had hitherto done, untrammelled by the Board of Trade and unfettered by having to apply for licenses, and being obliged to stand or fall on their own merits. There was another point—the interests of the ratepayers—and he regarded the continual attempts to press more and more heavily upon them as really abominable. Let them burn tallow candles, gas, or the costly electric light as they pleased, but do not, he said, compel them to do either of the three.

Mr. MACIVER considered that the objections to the Bill were rather increased than decreased by the speech of the President of the Board of Trade, who had dealt with the matter as if there were only two interests involved. He seemed altogether to overlook such cases, and they were numerous, as that of the Corporation of Birkenhead, who were the owners of the gasworks. There was no feeling of antagonism towards the electric light, but that was hardly a reason why its promoters should have advantages which those who at an earlier time embarked in the gas project did not possess. All that was wanted was absolute fair play, and he contended that those who were connected with electric lighting should be put on the same footing in the matter of competition as the other companies. He concurred in what the hon. member who had just spoken had said with respect to the Board of Trade. It was a department of which he had had very long experience from various points of view, and while he had always—and with reason—regarded certain of its members with respect, he looked upon it as a department which, in more than one particular, was thoroughly incompetent. The Speaker, he hoped, would pardon him for saying this, because not only he, but also the Archbishop of Canterbury, was a member of the Board [laughter], but he supposed that neither of them took any active part in its duties. If they did, no doubt his objections would be entirely removed [laughter], and the work imposed by the Bill would be in good hands. But no one knew to whom these powers would be entrusted, and he considered it wrong that the Board should possess them. He looked upon the illustration taken by the right hon. gentleman from the case of the tramways as most unfortunate and incomplete.

Colonel MAKINS said that, after the discussion which had taken place, he did not intend to press his amendment.

The amendment was then by leave withdrawn, and the House went into Committee on the Bill.

Clause 1 (short title) was agreed to.

On Clause 2, which deals with the granting of licenses, authorising the supply of electricity,

Mr. CORBETT called attention to Sub-Section 2, which set forth that a license should be for any period not exceeding five years, but might, at the expiration of such license, be renewed at any time with the consent of the local authority, upon such terms and conditions as the Board of Works might determine. He moved to leave out the word "five" and insert "seven."

Mr. CHAMBERLAIN said that the only case in which the license could not be renewed was in the case of the local authority refusing its consent. If the hon. gentleman proposed that the Board of Trade should go outside the consent of the local authority, they would be usurping the authority of Parliament in a way they had never hitherto attempted to usurp it. It was one thing to say that the Board of Trade should be empowered to grant a license with the consent of the local authority, but it was

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another and very different thing to say that it should act without that consent.

Mr. MACIVER wished to know who were the Board of Trade for the purposes of this Act?

Mr. CHAMBERLAIN replied that it was quite true that, technically, the constitution included the Archbishop of Canterbury, the Prime Minister, Mr. Speaker, and many other personages, but the board for many years had never met.

Sir J. LUBBOCK pointed out that a company might say to a local authority that, "We will not go to the expense of laying down wires and procuring plant for the short space of five years, but we will make the experiment if you will guarantee us an existence of ten years." Would it be in the power of the local authority to give such a guarantee?

Mr. CHAMBERLAIN said there was nothing in the Bill to prevent a local authority from agreeing with a company that at the expiration of five years their consent should continue. A question had been asked on this point on a previous occasion, and there had been some discussion on the point.

Mr. W. FOWLER said that at the end of the first five years there might be a new corporation, and a bargain made by their predecessors would not be binding on the new body.

Mr. CHAMBERLAIN said that corporations were continually binding their successors.

Sir G. CAMPBELL said it appeared to him to be a most alarming doctrine. One corporation might be in office for five years and it might be followed by another of totally different views on local politics, and yet they were to be bound to accept the policy of their predecessors.

Mr. CHAMBERLAIN said the successors of a corporation would not be bound as to policy, but only in the carrying out of a contract. The consent of the Board of Trade to the renewal of a license would still be required.

Mr. W. FOWLER said a corporation could not bind its successors beyond the spirit of the Act.

Mr. Serjeant SIMON said that a corporation was a perpetual body, and could enter into an agreement in perpetuity for any term of years. There could be no doubt in the mind of any lawyer on this point.

Mr. SHAW thought it would be well for the inquiries of the Board of Trade to be made locally. He considered the period mentioned in the Bill—viz., five years—would be a very short one, and capitalists would be loth to embark their money in enterprises which might be of such short duration.

Mr. CHAMBERLAIN said the points raised by the hon. member were of great importance, and he (Mr. Chamberlain) was in sympathy with the hon. member. It would be desirable that in many cases local inquiries should be held; and, although these were not provided for in the Bill, they would be provided for in the regulations framed by the Board of Trade. As to the period over which the electrical experiments might extend, they could be conducted by provisional order as well as by license; and, in that case, Parliament would be able to authorise the continuance of a scheme.

After some further conversation the amendment was withdrawn.

Mr. WARTON moved to amend the sub-section by providing that the license could be renewed at the expiration of the period of five years, "or at any time after" that expiration.

Mr. CHAMBERLAIN promised to consider the point, and, if there was a defect in the Bill, to amend it on report.

The amendment was accordingly withdrawn.

Mr. WARTON then proposed words to make the renewal "for a like period" to that of the original license.

The ATTORNEY-GENERAL said the period was governed by words in the earlier part of the sub-section.

Colonel MAKINS wished to know how many renewals could take place before it became necessary to apply for a provisional order? It was very important that the committee should come to a decision in these matters, and it was quite evident that before five years were over the company supplying the light must give satisfaction to the local authorities, or else the whole thing would lapse. He moved the omission of the words "at any time," which would compel the parties to come to some arrangement with the local authorities.

Mr. CHAMBERLAIN pointed out that the effect of omitting these words would be to provide for only one renewal of the license and no more. He thought there should be a continuing power to grant renewals so long as the conditions existed. However, he quite understood the object to attain which the amendment was moved, and he promised to consult the draughtsman, and if it were found necessary for the sake of greater clearness to make any alteration in the language of the clause he would bring it up at a later stage.

After some further discussion, the amendment was withdrawn.

Mr. CALLAN moved an amendment providing that the notices given to the public should state fully the terms on which it was proposed that the electric light should be supplied, in order that all who were interested should know what those terms were.

Mr. CHAMBERLAIN explained that the object in view was attained as well as it could be by Clause 3. It would be difficult to insert the terms in the application, for they could only be arrived at after full consideration between the parties.

The amendment was withdrawn.

Mr. MACIVER moved an amendment, to substitute for "the Board of Trade" the words "the President of the Board of Trade" as the controlling authority. They all knew in that House that for all practical purposes the President was the Board of Trade, but that fact was not so well known by the public outside.

Mr. CHAMBERLAIN could hardly believe that the hon. gentleman was serious in proposing to make a great constitutional change in an amendment to an electric lighting bill. The adoption of the amendment would raise all sorts of difficulties.

On the question that Clause 2 stand part of the Bill,

Colonel MAKINS made a final protest against the measure, on the ground that it set a bad precedent and introduced a new principle, under which great public works were to be sanctioned or legislated for not by Parliament but by the Board of Trade. It might hereafter come to happen that local authorities would obtain licenses from the Board of Trade for the construction of docks or railways, or the carrying out of almost any sort of enterprise.

Mr. FRITH suggested that the publication of notices, &c., might give sufficient publicity to provincial schemes, but it would never inform the ratepayers of the metropolis in regard to London schemes. He hoped the Government would consider whether different provisions could not be made for London in regard to this matter.

The clause was then agreed to, as were Clauses 3 and 4. On Clause 5,

Mr. BOLTON moved an amendment, the object of which was to make it perfectly clear that only those who availed themselves of the option given under the Bill to use the electric light should be rendered liable to pay for it. It was evident that, as the clause stood at present, the local authority might enter into a speculation to provide an electric light for any locality, and charge a very low price for the use of it, and then avail themselves of this clause, by which others, who were not using the light at all, were assessed for the cost.

Mr. CHAMBERLAIN said that some sort of confidence must be reposed in the common justice and honesty of the local authorities. If those authorities were to act in the manner suggested by Mr. Bolton, they could not possibly remain in office.

The amendment was negatived.

Mr. PUGH moved an amendment providing that no local authority should be empowered to enter upon a scheme for electric lighting unless it had previously obtained the definite sanction of the ratepayers. He pointed out that the Borough Funds Act provided that no corporation or other local authority should embark upon any expensive scheme unless the ratepayers had been consulted in the matter. He cared little whether the sanction was given by a meeting of the ratepayers or by some local inquiry, but that such sanction was necessary he believed all hon. gentlemen would admit.

Colonel MAKINS was glad the hon. member had proposed this amendment, though he was not sure that by proposing to embody a section of the Borough Funds Act he had adopted the wisest course to secure the end in view. He observed that in a later portion of the Bill it was provided that an inquiry "may" be held into the merits of an electric lighting scheme. If the President of the Board of Trade would consent to make the inquiry compulsory, there would be no need for the present amendment.

Mr. CHAMBERLAIN did not think the amendment would attain the object for the hon. gentleman, for its effect would be that a local authority would have to obtain the consent of the ratepayers whenever they wished to incur fresh expense in connection with the undertaking. Such shackles were surely not necessary in the case of greater corporations, but he agreed that, in the case of local authorities in country districts, there was not that security which public opinion gave in large towns, and, therefore, something of the kind suggested was necessary. He must point out that under the existing law there was every security against an absolute abuse of power entrusted by ratepayers to their representatives.

The amendment was withdrawn.

Mr. NICHOLSON proposed that the licenses should be granted for twenty-one years instead of fifteen years. He believed that such an alteration would tend to the greater security of the capital invested.

Mr. CHAMBERLAIN said the term fixed in the Bill was the result of a compromise. Between the term of seven years originally appearing in the Bill and the term of twenty-one

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years which the counsel for the eletric companies argued in support of, the Committee took the middle course, believing that fifteen years gave sufficient time for the development of what really was an experiment, while to give a longer lease of monopoly might prejudice the interest of the public in favour of those of private speculators. The electric light companies all of them, with the exception of the Edison Light Company, had expressed themselves as satisfied with the term of fifteen years. In the company he had mentioned he believed his hon. friend was interested, but all the other companies had declared that the time (fifteen years) was quite sufficient to justify them in the experiments they desired to make.

Mr. CALLAN expressed his surprise that a member of the committee should be alluded to as interested in one particular company concerned in the result of the discussion. In private committees it was usual for every member to sign a declaration to the effect that he was not personally interested in the matter under investigation. He was sorry that a Minister should by his words give an implied sanction to the interference of a member in the proceedings of a committee in which he was personally interested [oh].

Mr. MORGAN LLOYD as a matter of order asked the chairman where they were [laughter]?

The CHAIRMAN having, in reply to this question and another put by Mr. Carbutt, explained that the point was simply whether the time within which the purchase should be effected should be fifteen or twenty-one years.

Colonel MAKINS explained that what Mr. Callan had said referred only to private Bills, not Bills of a public character.

Mr. M. HENRY also pointed out the same distinction.

Mr. CARBUTT supported the proposition for making the period fifteen years.

Mr. STOREY-MASKELYNE took the opposite view,

And the amendment was withdrawn.

Mr. NICHOLSON moved an amendment to provide that the purchase should be agreed upon with an undertaking for an addition for goodwill and compensation for severance.

This was opposed by Mr. RATHBONE, and supported by Sir J. LUBBOCK.

Mr. CHAMBERLAIN said: Of course, in the case of gas companies' plant being purchased, allowance would have to be made for the depreciation of plant by working, as was done in every other manufacturing trade. It must be remembered that though there was no purchase clause inserted in the Gas Acts, there was a clause limiting the dividends, and there was nothing of the kind in the present Bill.

Mr. CROSS would like it to be understood that nothing like the same exorbitant dividend would, or could, be paid by any electric lighting company as had been paid by the gas companies.

Mr. MORGAN LLOYD advised the insertion of a clause fixing the value of a going concern.

On Clause 20,

Mr. ION TRANT HAMILTON moved to insert after the word "modifications," "this Act shall be read and take effect, so far as Ireland is concerned, as if the Local Government Board for Ireland was in all instances substituted for the Board of Trade."

Mr. CHAMBERLAIN said the object of the Board of Trade was to consult the wishes of the Irish members so as to make the Bill as practicable as possible. The same provisions as applied to England and Scotland would be applied to Ireland and he respectfully asked his hon. friend to allow the amendment to be dropped.

Mr. STANHOPE thought it would be desirable to leave it in the ands of the Board of Trade.

Alderman BARRON moved the following amendment:—"No application for a provisional order on the part of any company or person shall be made in respect of all or any part of the district of a municipal or other local authority without six months' notice in writing (which shall define the area intended to be comprised therein) to such authority, who shall, within that period be entitled to make application for a provisional order in respect of all or any part (including the area defined in such notice) of such district; and, until such application has been disposed of, no other application shall be entertained."

Mr. RAMSAY moved to report progress, on the ground that the time allotted to the Bill by the President of the Board of Trade was past, and Scotch business was waiting that had been mentioned in the Queen's Speech three times; whereas this Bill had not been mentioned at all.

Mr. Serjeant SIMON hoped the motion to report progress would not be persisted in.

Sir G. CAMPBELL urged the House to go on with the Scotch Bill, even up to midnight.

Mr. STANHOPE asked for an assurance that the third order on the paper, the Annuities and Insurance Bill, would not be taken, protesting against English members being kept waiting several hours for that measure, while the Scotch Bill was being discussed.

Mr. RAMSAY explained that he made his motion because it was not right for the Government to have placed the Scotch Bill second on the paper. He would, however, withdraw his motion.

The motion having been withdrawn, some further discussion took place upon the amendment of the hon. member for Leeds, and eventually the committee divided, and rejected the amendment by 88 to 29.

The schedule of the Bill was agreed to, and the Bill passed through committee as amended.

THE SOUTH AFRICAN "BRUSH" ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of this Company was held at the Cannon-street Station Hotel, on the 17th inst., followed by the first ordinary general meeting, "for the purpose of transacting the ordinary business of the Company."

Lieut.-Colonel GEORGE COXON presided.

The SECRETARY (Mr. Thomas J. Seel) having read the notice convening the meetings,

The CHAIRMAN said: You are aware that this (referring to the extraordinary) meeting is called for the purpose of confirming the proceedings of the meeting, held recently in this hall, to rescind certain parts of the Articles of the Association. You are all in possession of the alterations proposed in the article, and I move the confirmation of the resolution.

Mr. ATKINSON having seconded the motion, it was carried unanimously.

The CHAIRMAN then said: I have now the honour to open the first general meeting of the Company. On the last occasion when we met there were certain queries put to us, I think, rather prematurely, considering that the Company had only just started, and I intimated that on this occasion we would be more prepared and ready to give any information with regard to the progress and operations and the prospects of the Company than we were then prepared to do. In pursuance of that engagement, I will, with your permission, read to you a few notes I have made on the subject of our proceedings, our wish being, of course, as representatives of the shareholders of this Company, and as custodians of their interests, to hold everything in common with them, and to retain nothing that should be made public. Of course there are certain matters, with regard to the terms of contracts particularly, that you will understand, as men of business, it would be absurd for us to make public - that is, I mean, to publish them to the whole world —no more than any one of you who are in business would think it wise to publish the terms of your contracts, or your business, to the world; but there is no shareholder to whom all the books and papers, and everything, even contracts, is not at all times open, and our secretary will always be prepared to give any information to any shareholder who may wish to have it. With regard to that there is no restriction. The Company was registered on the 13th of May last, and it will be no doubt satisfactory to the shareholders if I say a few words with reference to the position and prospects of the Company. The shareholders will remember that in 1881 Mr. Blain and Mr. Macdonald acquired from the Anglo-American Brush Electric Light Corporation (Limited) a license to use in South Africa the Brush system of electric lighting, and had sent to the Cape Mr. Donald Macdonald, who is now colonial manager of the Company; and they also purchased and forwarded to South Africa steam engines, dynamo machines, and plant, the Company acquiring from them not only the concession for the use of the Brush system, but all the plant in the colony and in transit, and the benefit of the contracts in negotiation which had been arranged, or were in course of being arranged. The shareholders will be aware that a company starting a new business, such as ours, will necessarily have to expend money in experiments, and in temporary installations, but the negotiations which had made most progress at the time of the incorporation of the Company related to the lighting of Kimberley with the electric light. So long ago as October last the manager reported that since his arrival at Kimberley he had had several conferences with the Town Council on the subject of lighting the town, and from what had transpired he believed there was every prospect of securing a good contract. From time to time he reported the progress which was made in the negotiations for the contract, and in January last he reported that he trusted soon to be able to state that the contract had been secured. I give you merely extracts of the letters bearing on this point, but I retain nothing which you should be made acquainted with. In February he reported that the experimental lights had been started at Kimberley, and that he was pushing on the final arrangements with the Council. On the 2nd of March he reported that the light had been going steadily, and had given general satisfaction, and he went on to say that he was negotiating for the permanent installation, and that the difficulty which stood in the way of making the contract was that it was understood that the lighting rate was not to exceed a penny in the pound, which was not sufficient to produce enough to provide sufficient remuneration for installing and working the thirty-two lamps required to light the town. And this is an important fact, that at that meeting an additional £3,000 was added to the rates generally, for the purpose of increasing the funds in hand for a lighting rate, in other words, £3,000 was added by the Corporation with the view of lighting the town with the electric lamp. He added that the whole question might again have to be submitted to a meeting of the ratepayers. Later on in the month Mr. Macdonald was informed that a meeting of ratepayers would immediately be called, and he thought his final proposal would be accepted, as a majority of the Council would support it, and the public had already declared in its favour. The terms of the proposal alluded to had previously been communicated by him to his principals here, and on the 11th of May (two days before the Company was registered) a telegram was received here, which ran as follows: —"Have made a contract for Kimberley." It was, therefore, gratifying to the directors to be able to announce, as they did in the prospectus, that a telegram had been received that a contract had been concluded with the

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Mayor and Town Council of Kimberley to light that town with the Brush electric light on terms which the directors believed would prove highly remunerative to the Company. Our manager has since communicated to the directors the heads of the proposed contract, as agreed to by the Town Council. The directors do not consider that it would be advisable, in the interests of the Company, to make public the terms of this contract, but they are such as they consider satisfactory in all respects; and negotiations are still going forward with every prospect of final success. With reference to the Kimberley contract, the directors have to add that, although the contract was approved, and a resolution to seal it passed by the Town Council, a minority of the ratepapers (the majority have voted in its favour), interested from other motives, are still endeavouring to prevent its being carried into effect, and have gone so far as to commence proceedings to restrain the Town Council on the ground that the Corporation, as at present constituted, is not a legal body, because the voters' list for the present year has not been published. With reference to this hitch, our manager, on the 17th June, reports as follows:—"I am in no way anxious as to the result, but some further delay will be involved, as in nearly all important cases appeal is made from the High Court of Griqualand West to the Supreme Court of Cape Town." New plant is on the way, and the work is being proceeded with in order to complete the contract, and the directors cannot but think that public feeling in Kimberley will be too strong for the opposition, and that matters will go forward shortly with more smoothness than at present. The additional plant necessary for the completion of this contract, having been telegraphed for, is now on the way out. Concurrently with these negotiations, our manager, whose zeal, untiring energy, and great ability we hope one day to point to as a chief factor in the success of the Company, had been negotiating for the lighting of the Cape Town docks, harbour, and railway station, and has, we are happy to be able to report, brought them to a successful issue [applause]. On May 2nd he writes, with reference to the experimental installation in the Cape Town Docks: "The lamps have worked perfectly since writing to you on the 26th ult., and without interruption." He added that it was probable he would be asked to submit an estimate for lighting the outskirts of the town, where the gas company, whose contract has been continued for another year, have refused to lay their mains owing to the small number of lights required. On May 30th he writes: "The lights in the dock are giving every satisfaction, and I have reason to believe they will be permanently established." On the 23rd May he writes: "The lights are working well in dock for thirteen hours per night, but the Board have not yet come to any decision. The engineer informs me that the only hesitation on the part of the commissiones is the want of a perfect assurance that the Brush system is the best. He has been able to satisfy them that it is the cheapest (this is the Government engineer, not ours, who has satisfied them it is the cheapest light), and I think there is little doubt that it will be adopted." He adds, "The new company should, I think, work up incandescent lighting for houses, which would open a larger field than mere street lighting in all the interior towns where gas is beyond reach." On June 9 he writes:—"If the Kimberley Mining Board do not undertake the lighting of the mine, the companies will certainly light their own works, and it is from this source that I anticipate our chief business at the fields, but, owing to the extreme depression now prevailing, it may take some time to develop this branch of our business." On June 16 he writes:—"You will see from a copy of the *Port Elizabeth Herald*, which I forward, that permission has been obtained from the Town Council of that town to exhibit a set of lamps in the streets." Not very long ago I think the Town Council of Port Elizabeth refused to say anything to us about the light. In the same letter he states that he has addressed letters to the Government and Table Bay Harbour Board to the effect that it is the intention of this Company to establish in Cape Town a general electrical business, and that we shall be prepared to enter into contracts for supplying lights as fixed rates per light, per annum, to be worked by our own staff, and at our own risk. On the 4th of this month we received the following satisfactory telegram from our own manager:—"Cape Town, Dock railway agreed; sail to-day." That pointed to the satisfactory conclusion of the contract as to the dock and railway. "Sail to-day" means this:—As soon as the Company was formed we found that there were a great many things that could be better discussed if our manager were present, for he so thoroughly knows everything in connection with our field of operations in the Cape. We thought if he were present here we should be able to see a little better before us. With reference to the extract from the letter of May 23 on the subject of domestic lighting, prior to the formation of this company, Mr. Alexander Macdonald, of Messrs. Blain, Macdonald, and Co., had been granted the refusal of the patents for South Africa, held by the Electrical Storage and Force Company (Sellon and Volckmar accumulator) on exceptionally favourable terms. I may add that we may now call that the Sellon, Volckmar, and Faure accumulator, because that company has absorbed the patents of Mr. Faure as well as the well-known patents of Messrs. Sellon and Volckmar. In fact, they cover now all the patents that are applicable to what we may look upon as the groundwork of electrical patents—this accumulator. Mr. Macdonald, our agent, alludes to the question of lighting solely, but I need not tell you that the facilities for lighting given by this valuable accumulator are only really a small part of the immense power and advantage we shall possess by holding this patent in the matter of tramways and force for machinery—in fact, force as well as light. On the formation of this Company the directors were enabled, through the good offices of Mr. Macdonald, to open negotiations with the Electrical Storage Company, which have resulted in their acquiring these patents on the same favourable terms. The terms are exceptionally favourable, and we are very pleased to be able to tell you that we are now—so far as that goes, being the holders of the exclusive rights of the Brush system and the Sellon Accumulator system for the Cape of Good Hope—masters of the situation. There is only one matter which calls for our attention, which is the confirmation of the appointment of Messrs. Deloitte, Dever, and Co., as auditors of the Company. I beg to propose that.

Mr. P. A. Lloyd, a shareholder, seconded the motion, which was carried unanimously.

Mr. E. Hornsby moved a vote of thanks to the chairman, which was seconded.

A Shareholder inquired whether it was the intention of the Company to apply for a Stock Exchange quotation.

The motion having been carried,

The Chairman stated that they had applied for a quotation, but they could not possibly get it until the clause in their Articles of Association, the alteration of which they had confirmed that day, was made. They were now in the hands of the Stock Exchange committee. He thanked them for the vote of thanks.

The meeting then separated.

THE ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION (LIMITED).

An extraordinary general meeting of the Anglo-American Brush Electric Light Corporation (Limited) was held at the Cannon-street Hotel on the 18th inst. Sir Henry Tyler, M.P., presided.

The Secretary having read the notice convening the meeting,

The Chairman said: We have asked you to be good enough to meet us here to-day in order to get us out of a little difficulty. The difficulty is rather a serious one, and so far as I am aware an unprecedented one; but the fact is that we have a good deal of money now that we wish to distribute among you, and we are, unfortunately, precluded by our Articles of Association from distributing it. Now, these Articles of Association are our law, we are entirely bound by them, and it is only on our personal responsibility that we can depart from them. The amount that we wish to distribute among you we have arrived at this morning, after looking through all the figures of the Company, so far as we are able to make them up to the present. The 91st of our Articles of Association says: "A statement of the true financial position of the corporation, and a general balance-sheet made up to and, as on the preceding 31st day of December, so far as the business of the corporation abroad will allow, shall be laid before each ordinary general meeting after the first general meeting." You, therefore, see that we only make up our accounts and have an ordinary general meeting once a year. Now, we have not thought it at all worth while on this occasion to go through the process of taking stock and doing all that we should do in making up our accounts as at the end of every year. We have, however, prepared a rough balance-sheet to satisfy ourselves as to the amount we should distribute if you are good enough to give us permission to do so, and in that way we have arrived at the sum of £245,000, which we have to pay you whenever you like to receive it, and we propose with your permission that it should be paid about the middle of August. To do that we must alter Article 85 of the Articles of Association, which says, "The directors may, of their own authority, once in every year pay to the members a sum on account of dividends not exceeding the rate of 10 per cent. per annum on their respective shares." It is quite clear that the legal gentlemen who drew the articles, as well as the directors who sit before you, had no idea when this Company was incorporated of the success it was likely to meet with, and therefore we were precluded by them, and we precluded ourselves from paying more by way of interim dividend than 10 per cent. per annum. Now, having as you see, some £245,000 to distribute among you (and that I may say is entirely out of the profits of this undertaking)—having that amount to distribute among you, we are obliged to ask you to allow us to alter this article of association, and we have done so merely repeating what is stated in the previous article. "That the entire net profits of the corporation shall belong to the holders of the shares of the corporation (I think you will admit that that is a sound doctrine), and shall be divided among all the shareholders in the capital of the corporation for the time being, issued and fully paid up, or deemed and taken as fully paid up, and on such (if any) shares not being fully paid up, then only in respect of such shares in proportion to the amount of all calls then paid on such shares." You see that in the resolution we put before you to-day, and in the new article we to-day propose to you we have carried out precisely what is prescribed in the 84th article. Our resolution to-day is "That the 85th of the Articles of Association be repealed, and that in lieu thereof the following be henceforth the 85th of such articles:—'85. The directors may, from time to time, of their own authority, pay to the members in proportion to the amounts paid up, or credited as paid up (the very words of the previous article), on the shares held by them respectively, such bonus and such interim dividends as in the judgment of the directors the position of the Corporation justifies.'" We consider, therefore, having, as I told you, looked through the figures this morning, that our position justifies our dividing among you this sum of £245,000 [applause]. We therefore recommend you to pass this resolution, in order to enable us to distribute the amount among you about the middle of August. I beg to move the resolution I have read.

Mr. J. S. Sellon: Gentlemen, I beg to second the resolution which the chairman has so well put before you. He has fully explained to you the reasons which make it desirable that this resolution should be carried, and therefore it is quite unnecessary that I should amplify those reasons. I therefore simply beg to second the resolution, hoping it will be your pleasure to accept it.

Mr. Isaac assumed that the amount proposed to be divided arose from the sale of licenses to other companies, which he held was a reduction of what constituted the property of the Company. He, therefore, suggested that instead of the distribution being as bonus, it should be a return of capital. If they could return the whole of the paid-up capital they would eventually be able to divide their dividends without the use of any capital at all, but if they divided the £245,000 as a bonus the shares would remain at the same relative value. He, therefore, proposed that the money proposed to be distributed as bonus should be distributed as return of capital.

The Chairman said that the motion was hardly in order, as the proposal he had moved was for the repealing of and the substitution of other words in an article of association. He had not asked for their assent to divide any money, but only to alter an article of association.

Mr. Isaac said he might not have put what he desired to bring before them in proper words, but he would move, "That the proposed resolution be amended to this extent, that after the words 'by them respectively,' there should be inserted the words 'such return of capital' instead of the words 'such bonus,'" &c.

Mr. Wm. Abbott: It does not seem to me that any one has risen to second the resolution of the hon. proprietor, and, therefore, I think I form a true

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estimate of the opinion of this meeting, that they do not quite agree with the resolution he has proposed as an amendment. I must candidly say I do not agree with the proposal of the honourable proprietor, and for this reason he is under a wrong impression in supposing that this Company has parted with any valuable portion of its property through having granted licenses or sold concessions for any particular part of this country or abroad. I should be glad to be corrected by you, Mr. Chairman, if I am wrong in supposing that the sale of these concessions—although we have parted with licenses to develop the Brush system in various parts of this country, and Europe—forms a very valuable adjunct to this Company, seeing that we shall manufacture the whole of the material these subsidiary companies employ. Therefore, these sales give us a very valuable outlet for the particular commodity with which we deal without any increase of capital to this Company. Now, so far as I can understand it, you establish really a goodwill of a going business —a profitable goodwill, which should, therefore, increase the value of the capital. But, in order to still further increase it, it is desirable that you should have, in addition to a large reserve fund which I hope you have created out of the sale of these concessions, a very large capital of your own, which should give you the command of the market in electrical light business. Therefore, I should look with considerable jealousy on the proproposal of the honourable proprietor, that any of the capital already subscribed should be returned to the shareholders for unprofitable employment, when in this Company it is so very profitably employed. It has been the fashion of companies from time to time at periods of great prosperity to reduce their capital. It was done with the Telegraph Construction Company—a favourite company with me—at a time when they made very large sums of money. The directors very wisely said "this is exceptional," and wrote down their plant, machinery, and goodwill, and returned that money to the extent of £8 a share to their proprietors. But it seems to me in this operation which you have engaged in that exactly the reverse has taken place. You have increased the value of your goodwill, and, therefore, in common sense, you cannot possibly write it down. I, therefore, trust you will not be led away by any such proposition. I commend you for proposing to divide £245,000 among the shareholders, presuming that before you arrived at that figure you took care to make ample provision for the future [hear, hear from the chairman]—to write down the patent rights, machinery, and so on, which always deteriorates, but surely you cannot have any justification for writing down a goodwill of a business which seems to me to be steadily on the increase.

Mr. STEWART asked whether the board were justified in allowing a portion of the proprietors to pay the sum of £10 on their shares without giving the same option to all proprietors, a great number of whom had only paid £4 on their shares. If there was no distinct justification for this he should move an amendment.

The CHAIRMAN: May I ask whether you are an original proprietor, because if you are you would know what are the facts of the case—that when this Company was first started, no one believing in the success we have now achieved, was very much inclined to put money into it, and when we issued the prospectus and asked for our capital, we had some difficulty in getting together what we wanted, and we did then invite all proprietors to pay up in full. We not only gave the opportunity but made the request, and urged them to do it, and therefore every proprietor had then the opportunity of paying up his shares in full. But I should like to tell now the whole story. There were some proprietors who, believing in the success of this electric light, did so, and now hold £10 shares. There was one gentleman in particular I remember (I will not mention his name, but I have no doubt he is present) who went to the secretary, and, having bought shares on which £4 had been paid, was anxious to pay a little more than he had done, after we had stopped the further payment. We had the money we wanted, and we said those who have paid £10 up to the present will hold £10 shares, and those who have paid £4, will hold only £4 shares from such and such a date. After that one gentleman went to our late secretary after the shares were at a premium, and wanted to go on paying up so as to make his £4 shares £10 shares. The matter came before the directors, who were obliged to honour the engagement of their secretary so far as it had been made, but we then put a stop to the operation, and no one was allowed to pay up on his £4 share. These are the exact facts of the case. I think that is what you wished to know.

Mr. BROOKSBANK observed that the gentleman who had proposed an amendment was quite out of order, and even the directors, potent as they were, had no power to reduce the capital, which was *ultra vires* He, however, considered that the last shareholder who spoke (Mr. Stewart) had uttered good sense. It was, he contended, a mere accident that made the £10 shares entitled to so much more bonus than those on which £4 had been paid, and he inquired whether it was the intention of the directors that they should continue £10 and £4 paid, or be made all £10. Surely it was a case of great hardship if those who had paid £4 were only to share *pro rata* in the proposed distribution. The directors, however, had only strict justice to administer, and not to take any advantage.

Mr. H. MAUDSLAY asked the amount which had been placed to the credit of the reserve fund of the Company.

The CHAIRMAN: As to that question, before coming into this room, as I told you, we went into certain figures. Our object in doing so was not only to see what amount we could offer you for distribution, but also to see what we had left to represent the capital and assets of the Company, and in doing so we found that there was a very large margin indeed representing the paid-up capital, and what we had in hand, and what we should retain after distributing this £245,000. We did so not so much on your account as on our own, because we said to ourselves we are not going to incur any liability. We are not going to touch the capital of the Company, but only divide the profits, and shall only ask the shareholders to receive among them profits, still retaining the capital of the Company intact, and a large margin beyond it. That is the position in which we are before you to-day. As to what Mr. Brooksbank said as to this being an accidental circumstance, I think it hardly an accidental circumstance whether a man subscribes £10 or £4. It may depend on the accident of how much he has at the moment to put into the company to which he wishes to subscribe; but that is the only accidental part of it. I think it was with great deliberation that gentlemen first subscribed their £10 or £4 when we offered them the option of subscribing the one or the other. I quite agree with Mr. Brooksbank that we wish to do even justice to every one. That is our desire. I should be very sorry to wrong any set of shareholders. One or two gentlemen representing the £4 shares have spoken very nicely and well their notions on the subject, but we have not heard anything from the £10 shareholders. I think that that is because there is no proposition to do injustice to the £10 shareholders, but if we were to give the shareholders who have paid only £4 a larger amount in this distribution than in proportion to the amount they have subscribed, we should have an outcry from the £10 shareholders. We do not wish to have an outcry. We are not going to do what we think, or you think, justice, but what is prescribed by the Articles of Association. He then again read Article 84, particularly calling attention to the wording to show that the profits were to be distributed in proportion to the amounts paid on the shares. Continuing, he said: Those articles were not put together with the view to this state of things, as it is quite clear from the following article that what has happened was not contemplated. We are bound to pay the profits to every man in the proportion that he has subscribed to the capital of the Company. And that really seems common sense on the face of it—that every one shall receive in proportion to what he subscribed, especially when every one had the option at the beginning to subscribe £10 or £4 as he pleased. I will, therefore, put this resolution. The amendment was no amendment whatever, because it was not seconded.

Mr. ISAAC wished it to be understood that he had not suggested that any larger proportion of the profits or return of capital should be given to the £4 shareholders than they were entitled to in proportion to their subscription to the capital of the Company.

The CHAIRMAN: You only did it in an indirect manner [laughter]. Having read the resolution, he added: I may mention that I have a very large amount of proxies, but I am sure that it is not necessary to refer to them. He then asked them to vote on the resolution in the usual manner, and declared it carried with two dissentients.

Mr. BROOKSBANK asked if they were to understand that in future they held only £4 shares. On the face of the document, he held £10 shares with £4 paid up.

The CHAIRMAN: When I said £4 shares I meant £10 shares with £4 paid up.

Mr. BROOKSBANK contended that if the Articles of Association were unjust the Court of Chancery would remedy that defect.

A SHAREHOLDER observed that the chairman was bound by the Articles of Association.

On the motion of Mr. MAUDSLAY, a vote of thanks was passed to the chairman.

The CHAIRMAN, in reply, said: I am very much obliged to you for so kindly proposing this vote, and carrying it with such cordiality. I hope that we shall go on and flourish, as we have done so marvellously up to the present time.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).

A half-yearly general meeting of this Company was held at 38, Old Broad-street, on the 18th inst., under the presidency of Sir D. Gooch, Bart., M.P.

The SECRETARY (Mr. W. Shuter) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, this is a meeting more for the purpose of your asking questions than for receiving any report from the directors. We present no report and accounts, but I will state shortly the work done during the past half year. We have manufactured about 1,000 miles of cable, and laid about 550 miles of the cable we have manufactured in the last year. We have also laid the German Union Company's cable between Emden and Valentia. That was completed in April by the "Scotia." We have repaired the North Sea cable, which is also now completed; and the "Kangaroo" has been twice to the Brazils to carry out cable for the Western and Brazilian Company, and to repair the Brazilian Submarine Company's cable, near Pernambuco. The "Scotia" has now been about two months in the Atlantic repairing the Brest—St. Pierre cable for the Anglo-American Company. She recovered the cable in about 1,940 fathoms of water, and repaired it, and put in 60 miles of new cable. She then began to repair the fault that has for some time existed in the cable near Brest. That she is now engaged in doing. She has recovered the ends and buoyed them, but the weather has been so bad that she has not been able to put in the new piece. We, however, hope that that will be completed soon—as soon as they get two or three days of fine, calm weather. She will then go to the Atlantic again to do some more repairs that are necessary there. It is a great thing to do to lift a cable which has been down twelve years in mid-Atlantic, repair it, put in a new piece, and restore the cable. The cable taken out was in fair condition—in fact, very good condition, considering the length of time it had been down, but there were some traces of defects taking placing at short intervals of the cable from some chemical action at the bottom of the sea. That did not continue far, but it was quite sufficient to create weak points in the cable. We thought it was almost more than we could expect to recover that cable and repair it at such a depth of water after so long a period. We are endeavouring to keep our works going by doing all we can to secure cable work. Having told you practically what we are doing, I am afraid I have nothing further to tell you as to the future. We are, of course, negotiating for work, and I hope we shall be able to continue as we have hitherto done. I shall be glad to answer any question if any gentleman has any to put.

Mr. HEALY: As to the 700 miles you have now of Government contract, is that work to be done in a hurry?

The CHAIRMAN: I do not quite know what you refer to.

Mr. HEALY: I have only heard it, and I asked you the question.

The CHAIRMAN: We have not a Government contract.

Mr. HEALY: But you had one.

The CHAIRMAN: We had one. We have laid a cable of 900 miles in the middle of the half year. There is no resolution to put, and if no other shareholder has any question to ask I must declare the meeting at an end.

A SHAREHOLDER: I think it right that we should propose a vote of

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thanks to the chairman before we leave. If there is not much to say, the chairman has at all events told us all, with his usual courtesy in the chair.

The motion was seconded, and carried unanimously.

The CHAIRMAN: I am very much obliged to you, gentlemen.

The proceedings then terminated.

THE CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).

The twenty-second ordinary general meeting of the shareholders took place at the Company's offices, No. 61, Old Broad-street, on Wednesday last, Mr. Thomas Hughes, the chairman, presiding.

Mr. JAMES SCOTT (the secretary) read the notice calling the meeting, and the report and accounts were taken as read.

The CHAIRMAN: I will then at once move "That the report and accounts as submitted to the meeting be received and adopted." The shareholders will have seen from the report that the half year has been the most successful that the Company has ever seen since its establishment, which will be, no doubt, as satisfactory to them as it has been to the board [hear, hear]. The traffic receipts—which is the best test—as compared with the traffic receipts of the corresponding half year of 1881, show an increase of £3,000, or very nearly so. With respect to the distribution the shareholders will see that again the board have thought it wise to carry a very considerable sum to the reserve fund. The shareholders who have attended here on other occasions are aware that this has been the policy of the board from the very commencement of the Company, and that the board will not feel themselves in a thoroughly satisfactory position until the reserve fund reaches £50,000 at least. You will be glad to see that that result is being very nearly approached, for the reserve fund now stands at the sum of £47,000. Then, I suppose, the shareholders will concur with the board in thinking that, under the circumstances, the dividend on the ordinary shares should be increased to 8 per cent. [hear, hear]. That is the recommendation that we lay before you for your assent. I do not believe there is any subject upon which I need trouble the shareholders further. They will have seen by the accounts that the expenses are practically the same, in fact some £200 less than in the corresponding period of last year, although the business has increased so largely. With regard to the question of the dispute in the Spanish Government, you will see that everything has been done to bring that to a conclusion which could be done, and we trust the result of the appeal will be at least to put us in a position of getting a return of the funds. After the ordinary business is transacted this meeting will have to be converted into an extraordinary meeting to deal with the question of the auditors. Therefore, without infringing on your time any further I will move "That the report and accounts as submitted to you be received and adopted" [hear, hear].

Mr. ALEXANDER F. LOW: I beg to second that.

Mr. GREENWOOD thought they would recognise their improved position more fully than the chairman in his modesty had been good enough to put it. They should congratulate the board on their successful management, and themselves upon their improved position resulting from such management (hear, hear]. They were in a better position, he thought, he might say certainly, than within his recollection, they had ever been before [hear, hear]. Proprietors would probably put the figures together for themselves, but if not, he could tell them that the earnings of the Company for the half year had amounted to 15 per cent. per annum. They were paying 8 per cent.; they were adding £1,700 to their balance, and £3,950 to reserve, which was equal to another 7 per cent. per annum. It was true that was the best half of the year, but taking the whole of the year they had earned and paid 7 per cent., and they had reserved another 2 per cent. per annum for the half year, which was equal to 1 per cent. for the year. This would make 8 per cent. in the earnings, besides adding to their reserve £7,000—it having stood at £40,000 at the beginning, and £47,000 at the end of the year—which was equal to a thirtieth part of the whole capital of the Company. He thought that could not be said of any other telegraphic company in existence, and they might fairly congratulate themselves on the improved position of affairs. The only thing which struck one as singular in a company in such a flourishing state, and with such a large actual balance in hand, was that it should be burdened with so heavy a charge as 10 per cent. per annum on preference shares. He did not complain of the terms on which these were issued, for he remembered the time when the preference shareholders came to the rescue. But now they were in an improved position, and were practically purchasing another cable out of revenue, he thought the time had arrived, and he had mentioned it to the board, when it would be well to consider whether it would not be advisable to place themselves in a better position in regard to the preference shares. There were three modes for doing that. One scheme would be the issuing of £100,000 of six per cent. preference shares to be given to the holders of the existing ten per cent. shares, yielding them the same income as they now had. The charge on the Company would be the same, but with this difference, that these shares should be convertible into ordinary shares within a limited period, at the optain of the holder, or failing that, at the end of a certain period to be redeemable by the Company at par. That was one scheme. Another might be for every share held by the preference holders they should be entitled to one share in the ordinary capital, and a sum of money which could be taken from the reserve. And a further mode would be to authorise the board to invest some of their surplus revenue in the purchase of some of their preference shares. At times they had been low in the market, but now they were scarcely to be had. It was possible, however, that executors and others might throw their shares on the market, and the board might have authority to purchase them. He could only congratulate the shareholders on the successful position they now found themselves in [hear, hear].

Mr. GRIFFITHS agreed with the last speaker in congratulating the shareholders on the position of the Company, also as to the advisability of dealing with the preference shares. At the same time, whatever plan was adopted must be a question of contract, as no preference shareholder could be compelled to surrender any of his rights.

Mr. NEWTON asked whether there was any prospect of the connection of the West Indian system and the Brazilian, which would increase their traffic? He would also like to know if the board had any further information with respect to the threatened competition at some future period of Mr. Jay Gould? With regard to the issue of capital to take the place of the 10 per cent. preference shares, he did not think it possible to alter the conditions of that issue. The only way to deal with it would be to give the preference holders the option of converting into ordinary shares.

The CHAIRMAN, in reply, said they were told that the Brazilian connection was not likely to be carried out at present. He hoped it would be at some future period as it would be a source of great profit to the Company. With respect to the threatened competition, so far as they had been advised, it had for the present at any rate entirely gone off. As to the 10 per cent. preferences it had been said that they would not be able to purchase the preference shares; but he believed that this will be by far the best way to deal with them. The board would, however, take the matter into consideration, as it would be an advantage to the Company if they could arrange this affair of the preference shares.

Mr. GRIFFITHS remarked that some time since the Master of the Rolls decided that preference shares were a prior mortgage in a company. The company could not get rid of them in the bulk, but every single shareholder must be appealed to.

Mr. NEWTON agreed with Mr. Griffiths, and referred to a case in which every preference holder had to be asked for his signature, otherwise they might have upset the arrangement.

The resolution was then put and carried unanimously.

Dividends on the preference shares of 10 per cent., subject to income-tax, and of 8 per cent., free of income-tax, were next declared.

The retiring director, Mr. A. F. Law, was re-elected, the auditor, Mr. Greenwood, being also re-appointed.

A long discussion then ensued as to the desirability or otherwise of appointing a second auditor, the result being that the meeting by a majority of one decided in favour of a second auditor.

Mr. GREENWOOD then demanded a poll, which was taken forthwith, the result of it being in favour of only one auditor.

The meeting was then made special to pass certain resolutions carrying out the recommendations of the last meeting, that the board would have the power of filling up any casual vacancy in the office of auditor, subject to the notification of the next general meeting. After some discussion it was agreed to let the matter remain as before.

A cordial vote of thanks to the chairman and directors closed the proceedings.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES JULY 19.		BUSINESS DONE WEEK ENDING JULY 19. Highest.	Lowest
Anglo-American	49½,	50½	50¾	49¼
Do. Preferred	79,	80	80½	79
Do. Deferred	19½,	20½	21¼	19½
Brazil Submarine	11⅛,	11⅜	11⅜	11
Cuba	9¾,	10¼	—	—
Do. Preference	16,	17	—	—
Direct Spanish	6¼,	6¾	—	—
Do. Preference	15½,	16½	—	—
Direct United States Cable	11⅛,	11⅜	12	11¼
Eastern Telegraph	10⅛,	10⅜	10½	10
Do. 6 per Cent. Preference	13,	13¼	13¼	13¼
Do. 5 per Cent. Debentures, 1899	102,	107	—	—
Eastern Extension	11,	11¼	11¼	11
German Union	9¾,	10¼	—	—
Globe Telegraph and Trust Company	6⅛,	6⅜	6⅜	6 5-16
Do. Preference	12¼,	12½	12⅜	12⅜
Great Northern	12¼,	12¾	12½	12⅜
Indo-European	28,	29	28¼	28¼
Mediterranean Extension	2,	2½	—	—
Do. Preference	8½,	9	—	—
Reuter's	12¾,	13¼	—	—
Submarine	265,	275	—	—
West India and Panama	1½,	1¾	1 9-16	1 9-16
Do. 1st Preference	8,	8½	—	—
Western Brazilian	7,	7½	—	—
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	102,	105	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1¼,	1½	1 7-16	1¼
Oriental	⅜,	⅝	½	½
United Telephone	10¾,	11¼	12½	10⅜

ELECTRIC LIGHT.

Electric Light and Power	¼,	¾	¾	⅝
Anglo-American Brush	20½,	21½	24½	21⅜
Eastern Electric	3½,	4	4¼	4

TRAFFIC RECEIPTS FOR JUNE, 1882.

COMPANIES.	June, 1882.	June, 1881.	Incrse.	Decres
Cuba Submarine Company	2,900	2,837	63	—
Eastern Extension Telegraph Company	31,122	29,339	1,783	—
Eastern Telegraph Company	46,450	40,074	6,376	—
Great Northern Telegraph Company	22,560	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	3,425	3,405	20	—
Western and Brazilian Telegraph Company	—	—	—	—

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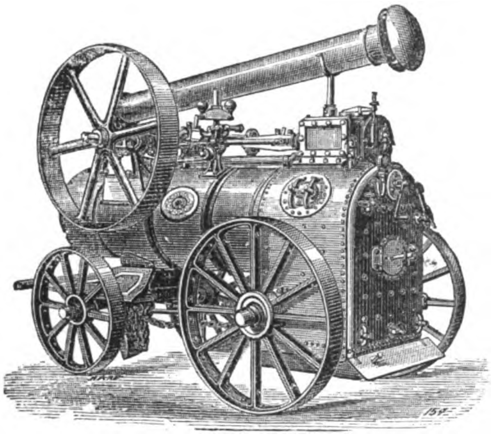

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NORTH-EAST COAST EXHIBITION OF NAVAL ARCHITECTURE, MARINE ENGINEERING, FISHERY, LIFE-SAVING, AND COAST-LIGHTING APPLIANCES.

To be opened at TYNEMOUTH on 6th SEPTEMBER, 1882, for not less than Twenty Days.

PATRONS.

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The Right Hon. EARL PERCY, M.P.

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PERCY G. B. WESTMACOTT, Esq., C.E., President of the Institute of Mechanical Engineers.

With others.

Sections.	Presidents.
Naval Architecture	Charles Mitchell, Esq.
Marine Engineering	F. C. Marshall, Esq.
Fisheries	J. M. Ridley, Esq., Chairman of the Tyne Salmon Conservancy.
Life Saving	Commander C. F. W. Johnson, R.N.
Coast Lighting, &c.	Capt. Watson and Capt. F. Smith, Trinity House, Newcastle.
Civil and Sub-Marine Engineering	P. J. Messent, Esq., Engineer to the River Tyne Commissioners, and H. H. Wake, Esq., Engineer to the River Wear Commissioners.

In connection with the Exhibition there will be a LOAN DEPARTMENT, and the committee will be glad to receive exhibits of all objects of marine interest. WORKMEN'S approved MODELS, EXHIBITS of COAL and COAL SHIPPING APPLIANCES will be received. An Exhibition of ELECTRIC and other PATENT LIGHTS will be included.

Diplomas and Medals will be awarded.

Applications for spaces must be made before 1st August.

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SIDNEY OLD, Acting Secretary.

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WANTED, ADDRESSES of CARBON CUTTERS. No. 2,203, "ELECTRICIAN" Office, 396, Strand, W.C.

BOILER EXPLOSIONS ACT, 1882.

NOTICE to POLICE and SANITARY AUTHORITIES and to the USERS of STEAM BOILERS.

The Boiler Explosions Act, 1882 (45 and 46 Vict., c. 22), is now in force.

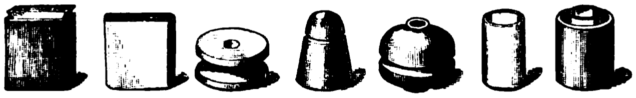
Users of Steam Boilers should at once obtain a copy of the Act in order that they may avoid the penalties attendant on a disregard of its provisions. The clerk of any police, or sanitary, or other local authority, and any user of a steam boiler (other than of a boiler used for domestic purposes) can obtain a copy of the Act gratis by making application by post to the undersigned within ten days from the date of this notice.

Issued by order of the Board of Trade, this 15th day of July, 1882.

THOMAS GRAY,
One of the Assistant Secretaries to the said Board,
7, Whitehall Gardens, S.W.

WANTED at once a thoroughly experienced MECHANICAL DRAUGHTSMAN accustomed to Electrical Work. Salary £2 2s. per week. Apply by letter only, stating qualifications, to Messrs. RANSOME, JOSSELYN, and WOODS, Battersea Foundry, London, S.W. Copies of testimonials only to be sent.

PRIZE MEDAL, PARIS ELECTRICAL EXHIBITION, 1881.



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Submarine Telegraph Company.—The half-yearly meeting of this company is to be held on the 1st August.

Brazilian Submarine Telegraph Company.—The traffic receipts of this Company for the week ended the 14th inst. amounted to £2,977.

Bahamas.—An American Telephone Company has been making arrangements for the introduction of the telephone into this West Indian colony.

Edison's Indian and Colonial Electric Company.—We are informed that Mr. John Forwood Tafe has been appointed secretary to this company.

Constantinople.—According to a Reuter's telegram, dated Alexandria, July 24, the English authorities have cut the Turkish telegraph line to Constantinople.

United Telephone Company.—The annual meeting of this company has been called for the 1st August. The directors will recommend a dividend of 5 per cent.

Discovery of Zinc Ore.—It is stated that new deposits of zinc ore, similar to those of Franklin and Sterling, have been quite recently discovered in New Jersey, U.S.A.

South African Telegraphs.—The revenue receipts from telegraphs in Cape Colony for May last amounted to £5,302, against £5,867 14s. for the same month of last year, or a decrease of £564 14s.

The "Orient."—This magnificent vessel, belonging to the Orient line of steamships, has been selected to take out a battalion of the Foot Guards for service in Egypt. She is lighted throughout by electric lights.

West India and Panama Telegraph Company.—The estimated receipts of this company for the half-month ended with July 15 were £2,521, against £2,135 in 1881. The March receipts, estimated at £7,345, realised £7,459.

Church Struck by Lightning.—On Tuesday week the church at Kilbirnie, in Scotland, was struck by lightning during a heavy thunderstorm. The stonework of the belfry was loosened and damaged, but nothing more serious occurred.

London Platino Brazilian Telegraph Company.—The revenue of this company for the month of April, 1882, is estimated at £1,595 (Western Brazilian portion £991, Land Lines £604), as against £1,787 for the corresponding period of 1881.

Western and Brazilian Telegraph Company.—The traffic receipts of this Company for the week ending the 14th inst. were £1,828, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

Eastern Extension Telegraph Company.—This company notify that the coupon on their 6 per cent debentures due the 1st of August prox., will be paid on and after that date at the Consolidated Bank, Threadneedle-street, E.C. Coupons must be left three clear days for examination.

Electric Lighting for Kidderminster.—The Town Council of Kidderminster are inviting tenders for lighting the borough for one year. Full particulars can be had of Mr. Arthur Comber, borough engineer, Town Hall, Kidderminster, and tenders are to be sent to him by 10 a.m. on the 9th August.

Post Office Volunteers and the War.—Amongst the volunteers who have been enrolled as a Post Office corps for the Egyptian expedition there are, we understand, several operators from the Central Telegraph station. It may be observed that telegraphists, as such, were not required for this special service.

Accident from Lightning.—At Newton Heath, in Lancashire, on Monday, a lad named Thomas Young was struck by lightning during a thunderstorm, and killed. It appears that he and two other boys were flying a kite at the time, and that all three were struck, though Young only was killed. It is mentioned that his clog was split by the current.

Central and South American Cable.—The India Rubber, Gutta Percha, and Telegraph Works Company have received telegrams announcing the completion of two more sections of the Central and South American Telegraph Company's cables—from Salina Cruz, in Mexico, to Libertad, in San Salvador, and from Libertad to San Juan del Sur, in Nicaragua.

Thunderstorms in Suffolk.—Severe thunderstorms are reported to have passed over the eastern part of Suffolk on Monday. The house of a man named Sudd, at Blaxhall, was struck by lightning and destroyed; and another cottage in a neighbouring parish—Stratford St. Andrew—was also struck. Telegraphic communication was interrupted for several hours.

Induction.—In our notice of Mr. Willoughby Smith's book on this subject we omitted to state that it is published by Messrs. Hayman Bros. and Lilly, of Hatton House, Farringdon-road, E.C. Several correspondents have asked us for details of Mr. Smith's apparatus. We take this opportunity of informing them that they will find full information in the above-mentioned work.

Electric Light for Cleethorpes.—We are informed that the Local Board of Cleethorpes, Lincolnshire, has entered into a three years' contract with the Brush Midland Electric Light and Power Company (Limited) for lighting the public streets with the Brush and Lane-Fox lights, and also that the inhabitants of the town are making arrangements to have the light laid on to the shops and houses.

Proposed Electric and Gas Exhibition.—The gas companies are moving in this matter with some energy. It is stated that the South Metropolitan Gas Company and the Crystal Palace District Gas Company have promised to subscribe £500 and £250 respectively towards a guarantee fund to defray expenses. It is also probable that the Gas Institute will organise a committee to look after gas interests.

The Brush Light on the Tyne.—There are now in use in different works on the Tyne 64 Brush lamps, distributed as follows:—16 at the Palmer Company's Engineering Works, 16 at Messrs. J. Redhead and Co.'s, South Shields; 16 at Messrs. Bell Brothers, Low Walker; and 16 at Messrs. Hawthorn's, St. Peter's. In addition to these we believe that Messrs. A. Leslie and Co., of Hebburn, are about to light their works by 40 of these lamps.

The Electric Light and War.—The *Standard* Alexandria correspondent, telegraphing on the 23rd inst., says:—"The electric light has been established at Fort Komel, and last night illuminated the country outside the walls for miles round, the panoramic effect as the light swept round being very singular and striking." The same correspondent reports that among some eighty-five Europeans and native Christians and Jews who had been brutally tortured and murdered at Tanta were two English telegraphists.

A Hill Struck by Lightning.—During a heavy thunderstorm in the Shetland Islands on Monday, which lasted

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several hours, a hill three miles from Lerwick was struck by lightning, and huge masses of rock and *débris* were thrown down on the public road which the hill overhangs, filling up the road and valley at the other side, and suspending the traffic. The total weight of fallen rock is estimated at 400 tons, and a gang of thirty men have been working continuously to clear the road. Where the lightning struck the hill there is a deep rut extending down its face.

New Atlantic Cables.—*The Times* states that the persons who have been authorised by Congress to lay new cables between the United States and Europe are Robert Garrett, William F. Burns, and William F. Frick, and not the Baltimore and Ohio Railroad Company. Mr. Robert Garrett is a son of Mr. John W. Garrett, the president of the Baltimore and Ohio Railroad, and is himself a vice-president of the line, with which Mr. Burns is also connected, but it is understood that he and his two associates are acting in this matter on their own account, and not on behalf of the railroad.

Telegraphic Communication with the West Indies.—The telegraphic delegates to the Barbadoes Conference have reported that they deem it unadvisable to attempt by temporarily raising the contribution of the Colony to maintain the present company, and that it will be better to try and secure direct communication with the Northern transatlantic lines. They suggest the appointment of a Board, to sit in London, which shall represent the various West Indian Colonies, to make necessary arrangements, and afterwards to supervise the working of the new line.—*Colonies and India.*

The Telephone and War.—The following passage occurs in Admiral Seymour's despatch to the Admiralty, dated June 12, relating to the disturbance at Alexandria:—"The telephonic communication which I reported in my previous letter had been established between the 'Helicon' and the British Consulate has proved of the utmost value to me since the outbreak of this *émeute*, and inspired the English residents with a certain amount of confidence, as by its means I have been kept constantly aware of the state of affairs generally. In default of this ready means of communication it would have been impossible for some hours to have gained any information from the town, except by special messengers at imminent risk of life."

The Telegraph Train for Egypt.—The *Standard* of Thursday says:—"C Troop Royal Engineer Train, who form the Field Telegraph Corps, consisting of 6 officers, 180 engineers, and 64 horses, will probably be the next troop to leave after the Guards, who are expected to sail on Saturday (to-day). This troop will take out six wire carts with reels, on which the telegraph cable is wound, and two covered waggons, which will form the offices to be affixed at each end of the wire for the receipt and despatch of telegrams. By this means the head-quarters of the general commanding will be in constant communication with the front. There will go out with the telegraph troop a number of experienced telegraphists from the postal department."

The Telephone in Alexandria.—The *Daily News* special correspondent telegraphed from that city on Friday, the 21st inst., as follows:—"A great portion of the Oriental Telephone Company's wires and property was destroyed in the town, and in the present state of affairs it is useless to attempt to put up public lines, but the company's manager and small staff are doing excellent service to the military establishments ashore. Lines have been run up and communication established between the Arsenal, the Raseltin Palace, the Zaptieh Tribunal, the head-quarters of the marines, and to-morrow the General will be in communication with each and all these, and it is impossible to calculate the saving of men and labour this simple instrument affords."

The Edison Light in London.—The Commissioners of Sewers have contracted with the Edison Electric Light Company to light Holborn-viaduct by means of Edison incandescent lamps, for six months, at the same price as gas. It will be remembered that the company have for some little time now been lighting the viaduct with their lamps entirely at their own cost, and as an experiment. We are glad to be able to chronicle their success in obtaining the above contract, and must congratulate Mr. Johnson, manager, and Mr. Hammer, engineer, on the result of their indefatigable energy. We gave a plan of the lighting in the Holborn-viaduct district, with particulars as to the number of lights employed, and other details, in our last volume (Vol. VIII., p. 368).

Electric Light in Engine Works.—The new marine engine works of Messrs. R. and W. Hawthorn, at St. Peter's, Newcastle-on-Tyne, have recently been fitted with the electric light. Altogether there are 16 Brush lamps in use, fourteen of which light the erecting and fitting shops, whilst two do duty in the copper and plumbing shops. The current is supplied by a Brush dynamo machine driven by a pair of direct acting engines designed and constructed by Messrs. Hawthorn, all belting being thus avoided. Gas has now been entirely dispensed with in these works, and the electric lights are reported as giving every satisfaction. The lights have been erected, and the arrangements carried out for the Hammond Electric Light Company by their electrician, Mr. E. J. Jennings.

The Action of the Microphone.—According to recent experiments, reported by a contemporary to have been conducted by Professor Hughes and Mr. de la Rue, and also by Mr. Blyth, it appears that the action of the microphone is now proved to be due, not to variation of surface contact but to the sensitive electric discharge passing between the points. This is precisely the view taken of it by our journal when first the microphone was made public, and the view we have adhered to ever since. We now hear of a "flame microphone," and of speech being transmitted microphonically when directed upon a voltaic arc, as if the idea were quite a new one. The truth is, we suggested experiments in this direction, and predicted the results most explicitly two or three years ago. Everything relating to the explanation of microphonic phenomena has, in fact, turned out just as we asserted it would.

European, American, Canadian, and Asiatic Cable Company.—The prospectus of a new company under the above title has just been issued. It is to have a capital of £1,500,000 in £10 shares. The company have power to establish telegraphic communication between Sable Island and any other point on the Canadian shore and Great Britain, Ireland, and the continent of Europe, and from any point on the Pacific Coast of Canada to Japan and the continent of Asia. A contract has been entered into with Henley's Telegraph Works Company to lay down about 6,120 miles of cables, comprising two complete cables between England and Sable Island, and connections with Canada and the United States, at a cost of £1,443,176. Sir Samuel Canning and Robert Sabine, Esq., are consulting electricians and engineers to the company. The secretary (*pro tem.*) is Mr. S. L. Tomkins, and the offices are at 4, Coleman-street, E.C.

Proposed Exhibition at Tynemouth.—It is proposed to hold an exhibition of naval architecture, marine engineering, fishery, life-saving, and coast-lighting appliances, at

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Tynemouth, under the title of the "North-East Coast Exhibition," to open on the 6th September next, and continue for at least twenty days. Amongst other things, electric lights of all kinds will be shown. Applications for space are to be made before the 1st August to Mr. S. Old, acting secretary, at 21, Collingwood-street, Newcastle-on-Tyne. We believe that the exhibition is likely to be a success, as already the committee of organisation have had to requisition extra buildings, owing to the numerous demands for space. The guarantee fund has reached £4,250. In connection with this exhibition the Hammond Electric Light Company have, we believe, decided to light the whole of the aquarium, skating rink, and other portions of the building, as well as the two main routes from the railway station to the exhibition. Brush lamps will be used.

Electric Light in the Severn Tunnel.—In our issue of the 15th inst. we stated on what we thought to be good authority that "the Great Western Electric Light and Power Company has received an order from the contractor for the Severn Tunnel for dynamo and lamps for lighting up the tunnel during the progress of the works, and that a dynamo to drive forty lights has been sent down, together with its complement of lamps." Several of our contemporaries made the same statement, doubtless on the same authority. It will be well, therefore, to draw attention to a letter from Mr. Thomas A. Walker, contractor for the Severn Tunnel works, which appeared in the *Western Mail* for 26th July. Mr. Walker expresses surprise at the publication of the information given above, and states that he never heard of the Great Western Electric Light and Power Company until he read the paragraph containing the above news. The editor of the *Western Mail* states that he made the announcement on the authority of Mr. John Parsons, the manager of the Great Western Electric Light and Power Company.

Eastern Telegraph Station at Alexandria.—The *Daily News* correspondent at Alexandria, telegraphing on Friday, 21st July, says:—"The staff of the Eastern Telegraph Company are working actively to open their town office, and, a second cable having been brought into service yesterday, the pressure of business on one line will be taken off to the great relief of all concerned. The Eastern Telegraph building, known as the Maison Canelli, owes its safety to the fact that the Egyptian telegraph being in the same building, when the European clerks left, the native clerks kept working there until the 13th, and a guard of soldiers was told off by Arabi to protect them. The Eastern offices were entered, and all the instruments destroyed by a hammer which I picked up inside broken, and all the lines were cut by some one conversant with the working of telegraphs. The only clerk of the Eastern Telegraph Company, Mr. Ternant, who of his own accord, and contrary to the wishes of the manager, remained in the building during the bombardment, and who was so cruelly murdered, doubtless met his death at the hands of the same ruffians employed by Arabi to cut the wires."

Problem of the Wires.—Mr. H. R. Meyer, of Liverpool, has given in a little pamphlet a "solution of the problem of the wires." He points out that the applications of electricity increase so fast to the multiplication of wires overhead, that the progress of the near future will necessitate the adoption of other than overhead wires. There are some scientific mistakes in this pamphlet, such for example as "that as electricity appears to travel on the surface of a conductor, the more surface is provided the less friction, or, as it is technically called, 'resistance,' and consequent loss of power takes place." In dynamic electricity, it is sectional area and not surface that decreases or increases resistance. Such mistakes, however, have little to do with the plan suggested, viz., to have grooved slabs of earthenware, cement, glass, or other suitable material, which can be laid end to end and the naked wires placed in the grooves, asphalte being freely poured over to act as an insulator. Such slabs could be placed one above the other or side by side in such a manner as to cause little trouble in getting at the wires if required, but it is supposed that the method would be so efficacious as to require little or no trouble after once laid.

Indo-European Telegraph Department.—In a resolution of the Government of India, reviewing the administration report of the Indo-European Telegraph Department for 1880-81, it is stated that the receipts amounted to £88,474 10s. 10d., showing an increase of £7,330 5s. 11d. over those of the previous year, most of the increase being due to increased receipts from the common purse arrangement. The expenditure of the year was £73,113 2s. 10d. being somewhat higher than the normal expenditure of the previous year, owing to increased cost of repairs. The net balance of the year's revenue over working expenses amounted to £15,361 10s.; but this does not include the earnings of the "Patrick Stewart" for services rendered to other departments, amounting to £1,078 6s., and the value of the "Amberwitch" (£4,000) transferred to the Marine Department. Including these items, the net revenue is increased to £20,439 16s., representing a profit of 1·77 per cent. on the capital outlay. Considerable damage was done to the lines in Persia by the storms during the winter, which were exceptionally severe, and the cost of repairs has been consequently somewhat heavier than usual; but, on the other hand, the wilful damage done to the lines was only of a trivial nature. The general results of the year's operations are declared to be very satisfactory, so far as the working of the telegraph service and the efficiency of the lines are concerned, and the Government of India concurs in the commendations by the Director-in-Chief of the staff, through whose exertions such good results have been obtained. But the financial condition of the administration requires careful consideration. The Government of India notes with approval that efforts are being made to increase the traffic, and it may be noted that some reductions have been made in the cost of working since the report under review was written. The total revenue is the largest that has been earned since the alternative route *viâ* Suez was completed, and there seems to be a fair prospect of the revenue increasing; but as yet it does not yield an adequate return on the capital invested, and endeavours must not be relaxed to secure such a diminution of working expenses as shall, without risking the efficiency of the service, leave a fair balance for interest on the capital invested. —*Homeward Mail.*

Why the Electric Light Goes Out.—Recently we gave the reasons stated by Messrs. Siemens to account for the failure of their lamps during the period for which they lighted their district of the City, viz., April, 1881, to March, 1882. We now give similar information from the report of Mr. Haywood to the Commissioners of Sewers relating to the Brush Company. The reasons given by this company for the failure of their lamps are as follow:—"Lace of driving band broke," "switched out maliciously," "defect in carbon," "top carbon fell down from holder," "stop valve broke," "inequality of carbons fitted," "rod of lamp stopped by a little dirt," "nut connected with governor of steam engine broke," "through carbons having burnt out owing to extra burning in the day time on

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account of fog," "carbon rods carelessly cleaned by lamp trimmers," "put out by heavy gale of wind blowing," &c. This company in several cases question the correctness of the police return as to the length of time for which particular lamps were defective. The number of lamps reported as defective during the year in the Brush Company's district was 660, and the total number of hours for which they were defective was 3,142h. 25min. One hundred and eighty-nine lamps were reported to have gone out owing to defective machinery, 385 owing to defective cables, 24 owing to defective carbons, and 62 defects are classed as miscellaneous. Thus, the aggregate failures of the Brush lamps amounted to 3,142 hours of a single lamp, or about 2·21 per cent. of the entire lighting of their district during the twelve months, whilst in Messrs. Siemens's district the aggregate failures amounted to about 832 hours of a single lamp or 0·57 per cent. only. The number of hours for which the lamps in both districts were assumed to be alight was 4,300 hours, which gives for the Brush Company, with 33 lamps, an assumed total lighting of 141,900 hours of a single lamp, and for Messrs. Siemens, with 34 lamps, a total lighting of a single lamp of 146,200 hours. Speaking of these failures, Mr. Haywood says in his report: "It may be said broadly that in district No. 1 (Brush) a defect of longer or shorter duration occurred in something less than two lamps nightly out of the 33 lamps lighted, and that in district No. 3 (Siemens) a defect occurred in something like one nightly out of the 34 lamps lighted. It must, however, be noted that at an early stage of the experiment a continued series of defects occurred in the Brush system, owing to defective insulation being discovered in a cable, and a new cable had to be laid to rectify this. In Siemens's district defects also occurred in a portion of the system through damage caused by a barge to the conducting cable beneath London Bridge. Apart from these prolonged defects at the outset, the principal failures appear to be attributed by the contractors to defects in the carbons, and to other causes of a character which are likely to be considerably diminished in number as the manufactures improve and experience is gained. The total number of gas lamps in the City of London is 3,225. The number of defective lights observed by the police during the year 1881 was 2,509. The number during 1881 was much larger than usual, and was attributable to the long-continued and severe frosts."

The Proposed New Cable Company.—The following letter referring to the prospectus of the European, American, Canadian, and Asiatic Cable Company appeared in *The Times* of the 26th inst. over the signature of Mr. H. Weaver, managing director of the Anglo-American Telegraph Company. Mr. Weaver writes:—"Sir: I beg permission to call attention to some omissions and errors in the prospectus of the above company. 1. The Anglo-American is the only company which has abandoned any of its Atlantic cables, and the cables so abandoned have been replaced out of revenue. 2. Instead of the five cables mentioned in the table of capital and cables of the existing companies, there are eight cables with which the new company will have to reckon, the two new cables of the American Telegraph and Cable Company which were opened for traffic on the 15th of May last being altogether omitted. 3. An important feature of the new company is stated as follows: 'Instead of pursuing the vacillating policy hitherto in vogue of tentative reductions with alternating augmentations, a tariff of 9d. per word will be adopted.' The promoters take credit for the whole 9d. per word without deducting the payments to be made to the Postmaster-General and to the American and Canadian companies for the use of the connecting land lines on both sides of the Atlantic. These payments, according to my experience, will amount to 2d. per word. 4. In computing the 'entire working capacity of the proposed two cables'—namely, 10,000,000 words per annum, upon which the financial results are based—each cable will have to carry 16,600 words per day, and as the maximum number of hours during which the cables would be employed is about sixteen, I have no hesitation in saying that the alleged 'entire working capacity' is overstated by at least 50 per cent. 5. The calculations of revenue based on such a foundation are, of course, hypothetical, and as I am in possession of actual statistics bearing directly upon the point it will be useful to state them. From the 1st of June to the end of September, 1880, the tariff of the Anglo-American Company was 6d. per word. The greatest number of words transmitted over the cables in any one month was 1,100,000, or say 13,000,000 per annum. In order, however, to give the promoter's calculations the full benefit of any possible increase I will take as the basis of calculation 16,000,000 words per annum as the total traffic to be transmitted by and divided between the four existing companies and the new company. 6. It cannot seriously be contemplated that the existing companies would stand quietly by and allow the new company to monopolise the entire traffic. The total number of all cables would be ten, of which I will assume the new company to possess two, and that these lines might obtain and carry one-fifth, or its due numerical proportion of the whole traffic. One-fifth of 16,000,000 words would be 3,200,000, which, at 9d. a word, would yield £120,000. Deduct—paid-outs to other administrations, say, 2d. per word, £26,000; renewal fund as per prospectus (quite inadequate for two cables), £45,000; working expenses, as per prospectus, £80,000—total, £115,000, showing a loss of £31,000 per annum, instead of the estimated profit of 17 per cent. on the new company's capital. Having regard to the above figures, it is needless to discuss 'the mutual feature,' since its introduction will scarcely make up for the unsoundness of the other financial features of the scheme." In *The Times* of the following day two letters appeared in answer to the above. One was from Mr. W. C. Jarvis, of the Home, Foreign, and Colonial Electric Light and Power Share Trust Company, 88, Bishopsgate-street, E.C., stating that with regard to paragraph 3 of Mr. Weaver's letter the payments for the use of the land lines have been carefully calculated to be 1½d., and not 2d., as stated by Mr. Weaver. The other letter was from Mr. S. L. Tomkins, secretary (*pro tem.*) to the proposed new cable company. This gentleman criticises Mr. Weaver's letter paragraph by paragraph. The sum of his contentions are, taking each paragraph in order, that—1. Three cables have been abandoned by the Anglo Company, and that the French cable has not been working for two months. 2. That this reduces the number of working cables to four, excluding Jay Gould's. 3. That Mr. Weaver's estimate of 2d. per word for payments for land lines, &c., is too high. 4. That a cable's carrying capacity is greater now than it was, owing to scientific advances, and that a cable may be worked twenty-four hours instead of sixteen. 5. That a permanent low rate and natural development of trade will cause a large increase in the total traffic of Atlantic cables. 6. That Mr. Weaver's calculations, being founded on the fact of there being ten cables and the new company's obtaining only one-fifth of the traffic are fallacious. That a lowering of rates by the older companies would mean a loss to them. That the Anglo Company themselves "reserved £75,000 for four old cables on a capital of £7,000,000. Of this sum £11,000 was actually expended during the year for repairs of cables."

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THE CRYSTAL PALACE EXHIBITION.

Post Office Exhibits.

(CONTINUED FROM PAGE 230.)

We have already alluded to the Wheatstone automatic system of telegraphy, by means of which despatches are transmitted at rates ranging from 50 to 250 words a minute. Formerly the Morse signs were produced by hand keying alone, but with a view to meet the pressure over certain routes, and to diminsh the number of wires, this fast method was devised. To obtain automatic transmission a slip of paper is perforated in such a way that as it runs through the "transmitter," represented on the right of Fig. 18, corresponding Morse characters appear in ink upon a band of paper at the distant station.

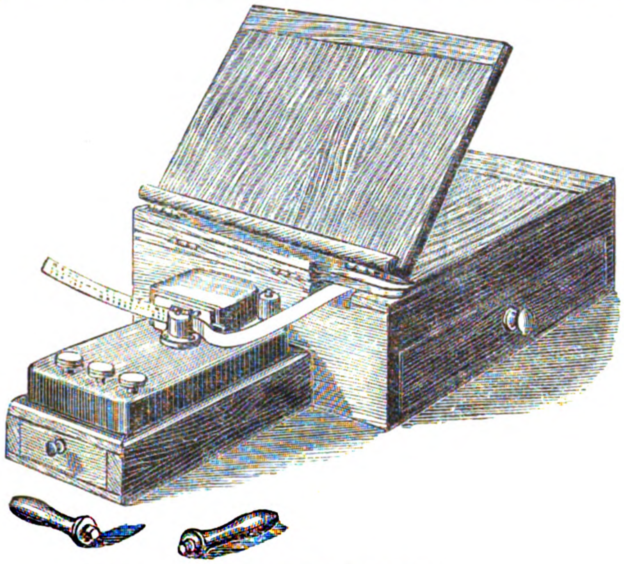

FIG. 16.—The Wheatstone Perforator.

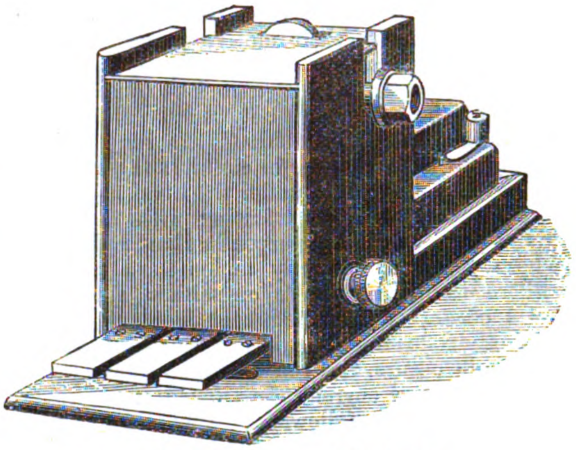

FIG. 17.—Pneumatic Perforator.

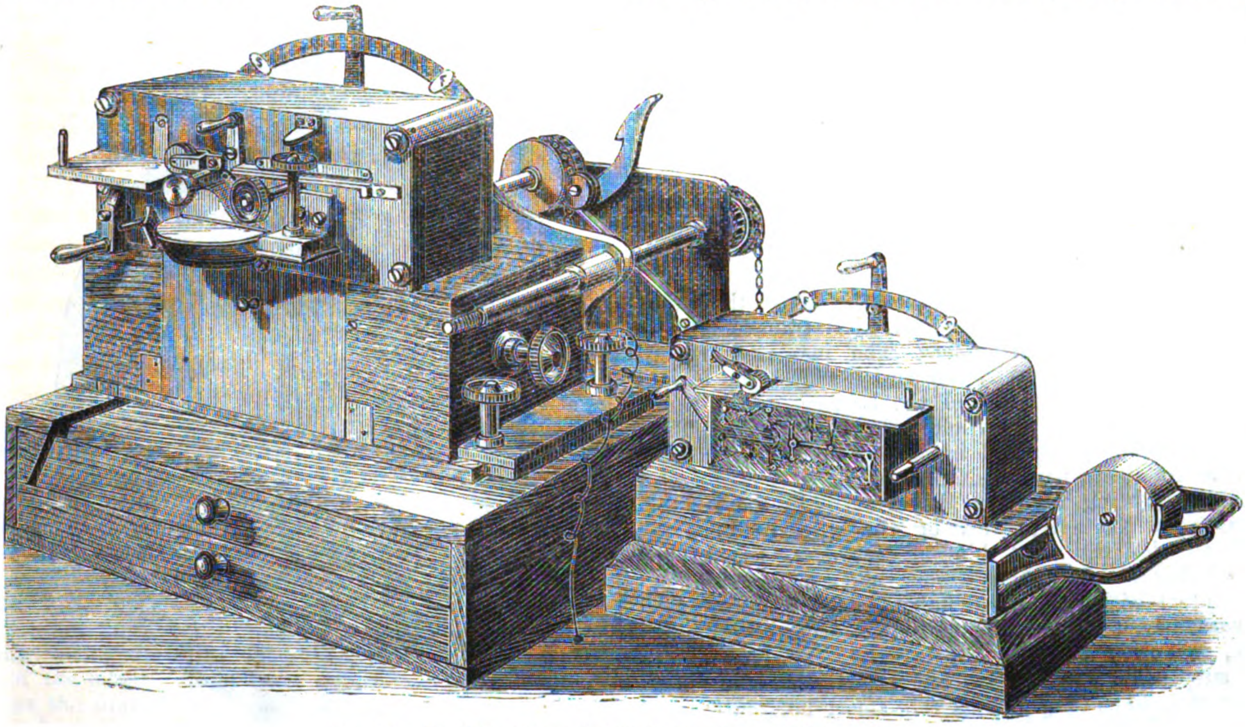

FIG. 18.—The Wheatstone Automatic Receiver and Transmitter.

The "perforator," Fig. 16, is purely a mechanical arrangement. It has three metallic discs, which, when depressed singly, cause levers to force the points of small rods through the paper slip, and to produce one, three, or four holes, as may be required. The disc on the left punches holes representing a dot, and that on the right the holes for a dash. The centre disc makes small spacing or guiding holes in the middle of the slip, and is struck once between letters and twice between words. A moderate pressure of fingers on either disc suffices to pierce the tape; but in practice iron mallets, as seen below the perforator, are used to give a stronger impetus to the blow. Each mallet is furnished with an india rubber pad at the end, which strikes the discs. The so-called dot or dash punctures consist of two round perforations separated by one or two of the central spacing holes—a pair of vertical holes representing the dot, a pair of oblique holes representing a dash. The punching rods are withdrawn from the holes in the paper by the return of compressed spiral springs to their normal tension of inactivity, and the paper is hitched forward at every blow by a small wheel having ten spokes on its periphery, and moving through $\frac{1}{10}$ or $\frac{2}{10}$ of its circumference. The space between the spokes is equal to that between the guiding holes of the slip, and as a click operates upon the wheel, so the spokes of the latter gear into the guiding holes of the paper, and drive it onward.

An expert operator is able to prepare the perforated slips in this way at a rate of forty words per minute for some

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time; but it must be obvious to our readers that the labour of wielding the iron mallets described above is considerable when the circuit is a busy one; hence, in order to save human energy, pneumatic pressure has been brought into requisition. Fig. 17 represents a frame containing an ordinary perforator, but in this case a gentle pressure on either of the three keys enables compressed air to force a piston down on the respective perforator discs beneath, and to prepare one or more slips as required. The number of punchers engaged in supplying one transmitter with slips depends upon the speed of signalling, and the speed of signalling, of course, depends upon the business to be done, as well as the condition and construction of the circuit.

The electrical "transmitter" and "receiver" are represented in Fig. 18, the former on the right, and the latter on the left side. They derive their motive power from heavy weights, which are wound up occasionally by hand. The speed of these instruments is regulated by the sliding arm seen at the top of the instrument between the stops lettered F and S, meaning "fast" and "slow." To send a message from a transmitter to a receiver in circuit, the punched slip is drawn forward by clockwork under the little roller which revolves over an aperture communicating with the interior. Under this roller are two perpendicular rods, almost parallel, whose points are directly under those portions of the slip where the larger holes on either side of the guiding holes occur. When the paper is blank, then the points of these rods simply press upwards against it; but, when a hole occurs, the rod instantly darts through, and causes a momentary current of a particular sign to circulate. This first current is followed by a momentary current of the opposite sign brought into action by the other rod. In the case of a dot, the interval between the two currents is short, while the duration of interval for a dash is double the length. The electro-magnetic effect of the first current causes a small inking wheel in the receiver to touch the moving paper tape there, and thus begins to make an ink line, which is afterwards broken by the succeeding short reverse current. The length of mark on the tape of the receiving end therefore depends upon the interval between the reverse currents, brought about by the holes in the transmitting slip.

THE BURGIN ARC LAMP.

The Bürgin electric lamp consists of a square box containing the regulator mechanism, of a tube guide for the upper movable carbon holder, and of the lantern where the arc between the two points of the carbon is formed.

Fig. 1 represents the whole length of the lamp, the tube being broken in order to insert a horizontal transverse section of the regulator mechanism. The insulated upper carbon holder is suspended by the cord *f*, whilst the lower carbon is fixed in the lower part of the lantern, and is thus in metallic contact with the whole body of the lamp. The regulator mechanism contained in the box up above is composed of the following parts:—N S horse shoe electro-magnet, capable of being regulated horizontally by the screws V V. One of the extremities of the wire bobbins is attached to the insulated binding screw *e*, the other extremity being attached to the copper tube serving as guide, and in contact with the carbon holder. The armature *i* is placed vertically, and forming one side of a movable parallelogram, the other side of which is fixed. The two other sides or suspension links *k l* are but slightly inclined from the horizontal, so as to give by a very small horizontal displacement as slight a vertical movement as possible to the armature. A very fine copper wire of high resistance envelopes the body of the armature, so that the magnetic poles produced are the same as the neighbouring poles of the electro-magnet. This fine wire is attached, on the one hand to the binding screw *e*, and on the other to the body of the lamp. The armature is bored throughout its length, and carries at the top the little pulley *b*. A support, *p*, is fixed against the armature. It holds the spindle *q*, upon which is keyed the flywheel R and the grooved pulleys *x* and *a*. The

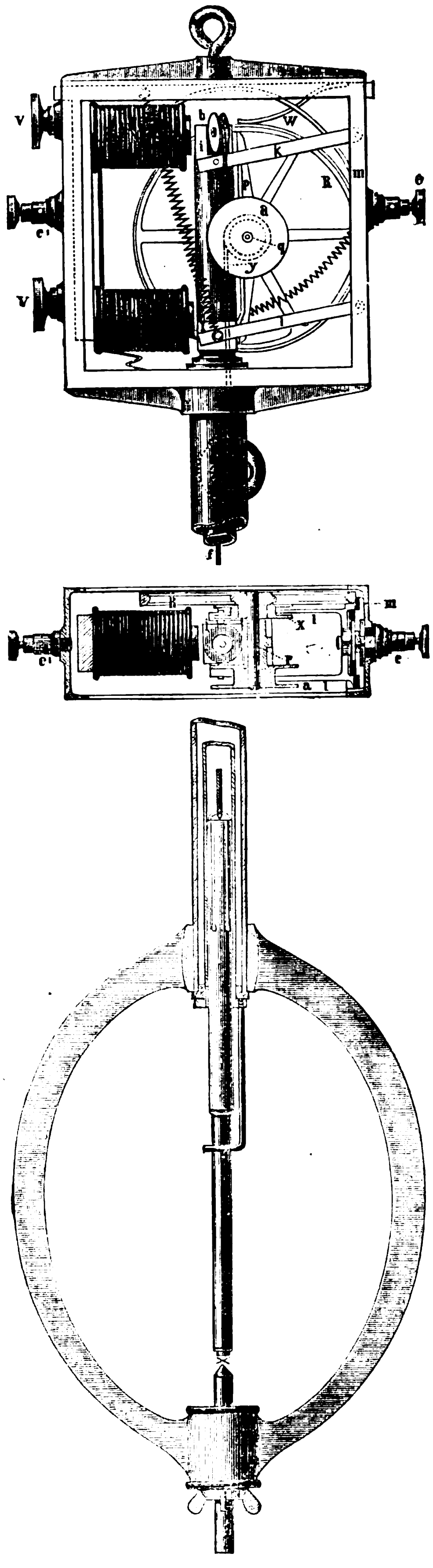

FIG. 1.—Regulating Mechanism and Holder of Bürgin Arc Lamp.

whole of this mechanism participates in the movement of the armature.

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The small cord, *f*, supports the upper carbon holder. This cord rises straight through the centre of the armature, passes over the pulley *b*, and round and round the drum *a*. A second cord, *y*, is rolled round the drum *x*. A copper ring is suspended to its other extremity, by means of which the upper carbon may be hauled up. A break, W, is in contact with the flywheel R; *e* is an insulated binding screw, receiving positive current. The negative binding screw *e'* is in metallic contact with the body of the lamp.

When the electric current enters the lamp by the binding screw *e*, it divides into two parallel currents, one of which flows round the bobbins of the electro-magnet, and on to the carbons, and the other through the fine wire round the armature. The intensity of the two currents is in inverse proportion to the resistance of their respective circuits, which is several hundred ohms for the fine wire, and one to three ohms for the electric arc. The electro magnet attracts the armature and raises it, at the same time presses the flywheel R against the spring W. From this moment the spindle *q* cannot turn, neither can the cord *f* unroll. The upper carbon holder which is suspended is forced to follow the upward movement of the armature until the reaction of the spring *w* causes an equilibrium to be maintained. In this manner the luminous arc is formed.

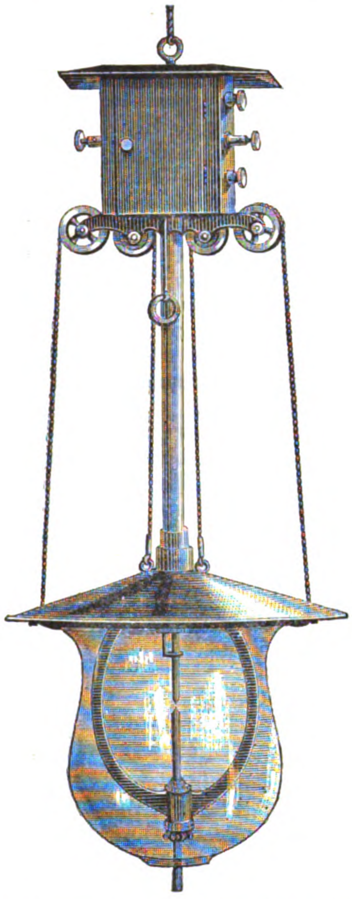

FIG. 2.—Bürgin Arc Lamp for Outdoor Use.

In consequence of the combustion of the two points of the carbons, the length of the arc, and at the same time its resistance, is increased little by little. The secondary current passing round the armature as well as the electro-magnetism of the latter consequently increase until the repulsion between the similar poles allows the armature to drop a little, the flywheel then becomes disengaged from the action of the spring break, and the upper carbon holder descends by its own weight. The secondary current round the armature and its magnetism diminish immediately, and the whole system enters into a state of fluctuating equilibrium between the combined action of the magnetic attraction and of the spring *w* on the one hand, and that of the weight of the carbon holder on the other. A continued but slow feed of the upper carbon ensues, so that the length of the arc remains constant. Each lamp regulates itself according to the length of its own arc, therefore several may be placed in series on the same circuit. The lamps are regulated by means of the screws V V, by which the electro-magnet is placed nearer to or farther from the armature, just as it is deemed advisable to lengthen or shorten the arc. The magnetic attraction and repulsion depend directly upon the intensity of the primary and secondary currents, owing to the mode of suspending the armature, which ensures almost a constant distance between the poles of the electro-magnet. The inconvenience attached to the ordinary mode of suspension, viz., that the magnetic attraction varies in proportion to the square of the interpolar distance, is here completely eliminated.

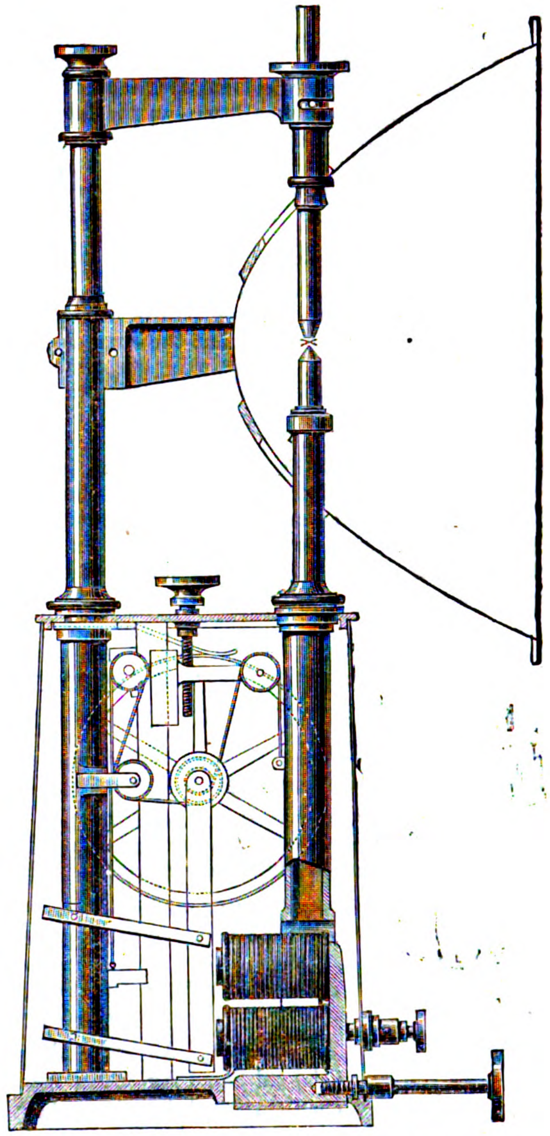

FIG. 3.—Bürgin Arc Lamp fitted with Parabolic Reflector.

Thus may be seen the possibility of obtaining with a regulator mechanism of great simplicity a lamp which will maintain a steady arc. Fig. 1 shows the arc in a position corresponding to the lower extremity of its course. The total length of this course, that is the distance between the highest and lowest points, is equal to a third of the length of the carbons. This is the length which the negative carbon will diminish in a given period. The upper positive carbon diminishes double this length in the same time; it therefore loses two-thirds of its length, and as at the same time it is forced to follow the lower carbon, its course is equal to its total length. The upper carbon holder stops against the wire guide at the instant when the lower carbon should be renewed; but the remainder of the upper carbon, being just

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one-third of the total length, is sufficient for replenishing for a complete period the lower carbon holder. The upper carbon holder receives then a complete carbon, and the lamp is ready for use. The period is eight hours when carbons 50cm. × 13mm. are used, and the current is 20 amperes. This current uses 6cm. of carbon per hour, of which four are used by the upper and two by the lower carbons, *i.e.*, in eight hours, 32 + 16 = 48cm. The remaining 2cm. of carbon can be thrown away.

Fig. 2 represents the one form of this lamp constructed for long carbons, to burn for periods of 12 to 14 hours, the length of a winter night. This lamp is intended to burn in the open air; it is, therefore, furnished with an overhanging top protector, a conical reflector, throwing downwards the light which would otherwise be lost, and a glass bell protecting the arc from the wind.

Fig. 3 represents the lamp with fixed focus, for scientific purposes, and projecting the light to a distance by parabolic reflectors, as well as for projection with obscure chamber. In the last case it has been employed in the laboratories of several European universities.

For projecting the light to a distance it is particularly appropriate to lighthouses, and has been employed on river steamers, &c. The regulator mechanism is the same as that employed in the suspended lamps, but the secondary current round the armature is useless in this lamp, as these lamps generally work one in a single circuit. The reason which causes the carbon points to approach each other when the arc is too long is that the current, and therefore the magnetism of the electro-magnets, diminishes and allows the armature with the flywheel to descend. The lower negative carbon is suspended to a drum half the diameter of that of the upper carbon holder. When the latter, consuming twice as fast, descends by its own weight, it raises the negative carbon half the distance which it falls itself; in this way the focus always remains at the same height.

The same lamp is also constructed with the upper carbon holder fixed in cases where a pedestal lamp is preferred to a suspended lamp.

ABSTRACT OF PAPER ON THE DETERMINATION OF CHEMICAL AFFINITY IN TERMS OF ELECTROMOTIVE FORCE.

Part VI.

On the Relations between the E.M.F.'s Developed in Cells Constructed like Daniell's Cell, but Containing Different Metals, and the Chemical Affinities involved in their Action.

BY C. R. ALDER WRIGHT, D.SC., F.R.S.

Numerous cells have been examined, containing the following combinations:—

I. .... Cd | $Cd SO_4$ | $Cu SO_4$ | Cu.
II. .... Zn | $Zn SO_4$ | $Cd SO_4$ | Cd.
III. .... Zn | $Zn SO_4$ | $Ag_2 SO_4$ | Ag.
IV. .... Cd | $Cd SO_4$ | $Ag_2 SO_4$ | Ag.
V. .... Cu | $Cu SO_4$ | $Ag_2 SO_4$ | Ag.

In all cases the two sulphate solutions employed were of equal molecular strengths, the strengths varying from MSO_4, SOH_2O to MSO_4, 1250 H_2O in the case of combination No. I.; and from MSO_4, 25 H_2O to MSO_4, 1250 H_2O with No. II.; and being MSO_4, 2390 H_2O in the case of the other three combinations. (Cold saturated silver sulphate solution.)

The effect of a given alteration in the character of either the zinc or copper plates when opposed to cadmium (cases I. and II.), was found to be practically indentical with that of the same alterations in the case of a Daniell cell, or combination

Zn | $Zn SO_4$ | $Cu SO_4$ | Cu.

Thus, the average effect of substituting amalgamated copper for freely-deposited electro-copper was to depress the E.M.F. by ·001 volt in each instance, and similarly in other cases. On the other hand, whilst the effect of a given alteration in the character of the cadmium plate was numerically sensibly the same, whether the cadmium were opposed to zinc or copper, yet the sign of the alteration was opposite in the two cases.

Effect of substituting for bright cadmium.	Cadmium opposed to zinc. Volts.	Cadmium opposed to copper. Volts.
Electro cadmium	− ·0005	+ ·0040
Amalgamated cadmium (fluid)...	+ ·043	− ·0415
Ditto do. (solid and crystalline)	+ ·016	− ·015

the + sign meaning increase in E.M.F., and the − sign depression thereof.

Similarly, the effect of a given alteration in the nature of the plate opposed to silver in cases III., IV., and V., was sensibly the same as that produced by the same alteration in any of the other cases; thus, substituting electro-cadmium for bright cadmium in combination IV. increased the E.M.F. by ·0040 volt, and similarly in the other cases. The effect of a given alteration in the nature of the silver plate was, in the same way, practically independent of the nature of the opposed metal.

Effect of substituting for bright silver.	Silver opposed to zinc. Volts.	Silver opposed to cadmium. Volts.	Silver opposed to copper. Volts.
Electro-silver (crystalline)..	+ ·008 ...	+ ·009 ...	+ ·0075
Amalgamated silver (fluid).	+ ·099 ...	+ ·101 ...	+ ·1025
Ditto do. (solid crystalline).	+ ·021 ...	— ...	—

It was, however, noticed that oxidation by dissolved air of zinc and copper plates took place much more rapidly when these metals were used in combinations III. and IV. (opposed to silver) than when opposed to one another in a Daniell cell, the fluids surrounding the oxidisable metals being the same in each case.

The following table gives the average values of the E.M.F.'s of the principal combinations examined, the E.M.F. of combinations I. and II. being sensibly independent of the strengths of the solutions used, provided both are of equal molecular strength:—

Combination I.	
Electro-copper, electro-cadmium	·7525
Electro-copper, bright cadmium	·7485
Amalgamated copper, electro-cadmium ...	·7515
Amalgamated copper, bright cadmium......	·7475
Combination II.	
Amalgamated zinc, electro-cadmium.........	·3595
Amalgamated zinc, bright cadmium	·364
Combination III.	
Amalgamated zinc, bright silver	1·528
Amalgamated zinc, electro-silver...............	1·536
Amalgamated zinc, amalgamated silver (liquid)	1·627
Combination IV.	
Bright cadmium, bright silver	1·1675
Bright cadmium, electro-silver..................	1·1765
Bright cadmium, amalgamated silver (liquid)	1·2685
Electro-cadmium, bright silver	1·1715
Electro-cadmium, electro-silver	1·1805
Electro-cadmium, amalgamated silver (liquid)	1·2725
Combination V.	
Electro-copper, bright silver	·416
Electro-copper, electro-silver	·4235
Electro-copper, amalgamated silver (liquid)	·5185
Amalgamated copper, bright silver............	·4165
Amalgamated copper, electro-silver	·424
Amalgamated copper, amalgamated silver (liquid)	·519

These values, and those quoted in Part V., show that Volta's "law of summation of E.M.F.'s" sensibly holds true in all the cases examined. Thus, the E.M.F.'s of the combinations amalgamated-zinc—bright cadmium, and bright cadmium—electro-copper are respectively ·3640 and ·7485 volts, giving as sum 1·1125 volts; whilst the average E.M.F.

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of the combination amalgamated zinc—electro-copper was found to be 1·114 volts; and similarly in all the other cases, the average deviation from equality being less than the probable error of the experiments.

On comparing these values with those deducible from Julius Thomsen's thermo-chemical data, a marked discrepancy is noticed between the combinations of form I. and II. and those of III., IV., and V. With the former cells the observed E.M.F. always sensibly accords with that deduced from the thermo-chemical data; with the latter it uniformly falls short by an amount between 0·3 and 0·4 volt. In order to compare the values for the cells containing amalgamated cadmium and silver plates, the heats of solution in mercury of the crystalline metals (precipitated respectively by zinc from the sulphate and by copper from the nitrate) were carefully determined by means of the calorimeter. Using the values thus obtained together with Thomsen's to calculate the heat of formation of cadmium and silver sulphates from the metal, not in the free states, but dissolved in mercury, the following values are finally arrived at:—

	E.M.F. calculated from thermo-chemical data.	Observed E.M.F.	Difference. Volt.
Combination I.			
Cadmium not amalgamated...	·740 + *x* ...	·7475 to ·7525 ...	less than ·02
Do. amalgamated	·727 + *x* ...	·706 to ·707 ...	less than ·02
Combination II.			
Cadmium not amalgamated...	·365 ...	·3595 to ·364 ...	less than ·03
Do. amalgamated	·378 ...	·407 ...	less than ·03
Combination III.			
Silver not amalgamated	1·890 ...	1·528 to 1·536 ...	about ·36
Do. amalgamated	1·981 ...	1·627 ...	about ·36
Combination IV.			
Silver not amalgamated	1·524 ...	1·1675 to 1·1805 ...	about ·35
Do. amalgamated	1·615 ...	1·2685 to 1·2725 ...	about ·34
Combination V.			
Silver not amalgamated	·784 ...	·416 to ·424 ...	about ·36
Do. amalgamated	·875 ...	·5185 to ·519 ...	about ·36

where x is a small + quantity depending on the molecular condition of the copper deposited. A number of experiments were also made on the effect of variations in current density on the E.M.F.'s of the various combinations, with the result of finding that all behave like a normal Daniell cell, the maximum E.M.F. being obtained either when no current at all passes, or when its density does not exceeed a few micro-amperes per square centimetre of plate surface, and the rate of fall in E.M.F. as the current density increases being a gradually retarding one; the actual diminution in E.M.F. for only moderately strong currents being upwards of 0·1 volt. As with the Daniell cell, this is due to peculiar actions taking place at each plate-surface, as well as to the formation of films of liquid of different densities surrounding the plates. The action of this kind taking place at the surface of the plate on which metal is deposited usually exceeds considerably that taking place at the surface of the other plate.

CORRESPONDENCE.

DYNAMOS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am obliged by the letters from correspondents, which appear under the above heading, in your issue of last Saturday; but, if I may again trespass on your valuable space, I should like to state that the engine is by one of our very best makers, quite new, and fitted with patent variable automatic governor expansion gear, which works exceedingly well. She is running well within her power, and could, without doubt, do three or four times the amount of work. I state this, as all your correspondents appear to think the fault may have been with the engine. I also took particular care that the lamps were perfectly free to work, and not out of adjustment in any way. The most likely cause appears to be that suggested by Mr. W. B. Sayers—viz., "That the magnetic system is in a state of unstable equilibrium," due to the "magnetic coupling" (if I may use such a phrase) of the two sets of field magnets. With reference to the letter of "Accumulator," I may mention that I have tried the machines and lamps coupled up in one circuit, but found this would not do, as the lamps are not provided with shunt coils, being only intended to work singly. A slight error of the compositor in my first letter to you may have caused some doubt as to the exact arrangement. The word "plates" in the fifth line should read "plate."—Yours, &c.,

WONDERER.

WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: If Mr. Johnstone cannot see what the real point at issue is, and what the preliminary points to be settled are as I see them, it is a waste of time for us to argue the matter together any longer in your pages.

I maintain that the point at issue is that raised by Mr. Johnstone himself, "Is electricity matter?" and I have proved a *non sequitur* to his deductions from his experimental facts, which latter I have neither admitted nor disputed.

The preliminary work may take several channels of investigation, Mr. Johnstone's dictatorial statements to the contrary notwithstanding; and I would sit and cogitate on the phenomenon of the *induction coil* until it seemed to point to a *material agency*, rather than *assume* such an agency, and make an experiment to prove it.

Surely such a question as the *transmutation of forces* need not be raised. I will not insinuate that Mr. Johnstone is ignorant of the action that takes place in a telephone circuit, though he has set me a different example. Force is transmutable, therefore Mr. J's "fundamental question" is answered.

In a small treatise by Sir W. Snow Harris, pages 74-75, I find the investigation of the Leyden jar by Watson, Smeaton, and their contemporaries recorded, and the following passage occurs:—

"... a succession of sparks will be observed to pass into the jar; these will become gradually weaker when the jar is fully charged."

The cessation of a current under those conditions, therefore, is *not* a discovery of Mr. Johnstone's.

Mr. J.'s experimenta have never proved anything but *effect*, and *cause* has been assumed; they as reasonably point to 50 electricities as *one* electricity.

I have never said that "electricity is divisible." Mr. Johnstone must not descend to misstatements. What I have *implied* is, that its *effect* is divisible, and two galvanometers inserted in a loop in a circuit will prove it.

The last line of page 62 and the first of page 63, *The Electrician*, 3rd June, 1882, read as follows:—"Whereas, I (Mr. Johnstone) maintain that electricity has no repellent power, all the phenomena supposed to be from repulsion arose from attraction." Mr. Johnstone politely alludes to the worthlessness of *my* writings. Ahem!

All that Mr. J. has ascertained is what every schoolboy student of electricity knows. To his deductions I reply, *non sequitur*; and, finally, Mr. Johnstone, by his advocacy of the motion of electrical "matter," has most ably exploded it.—Yours, &c.,

D. HARBORD.

Bridge-road, Redhill,
July 24, 1882.

FIRE RISKS FROM ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The rules drawn up by the committee appointed by the Society of Telegraph Engineers and Electricians, and published in *The Electrician* of July 8, will no doubt be subjected to criticism from many quarters.

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Electric lighting is passing through an ordeal, the severity and nature of which the committee do not appreciate.

It is, therefore, the duty of any one who has the right knowledge to test the merits of what these eminent men call "rules."

If insurance companies put forth "rules" they must be accepted as conditions on which alone risk will be taken by them at the ordinary rate, and if their rules are found to stipulate for either expensive methods to avoid infinitesimal risk, or simple and cheap methods of producing great risk, as is formulated in the Phœnix rules, they will soon have to be amended; but the credit of the craft is not endangered, as must be that of electricians, if they cannot prescribe specific conditions of safety in the installation of electric light plant.

The Phœnix rules are explicit, but in some points erroneous. The society's rules evade palpable error by a judicious reserve just where explicit instruction is wanted. I find ample justification for this charge in the preamble before reaching the "rules." Indeed, the first sentence of the preamble is intended to mean so much less than it says—if any one can tell what it says—that I can hardly venture to deal with it, as yours is not a comic paper.

The next sentence and the last sentence of the preamble so emphatically contradict what the first sentence seems to say, that for fear of seeming unfair I must quote all three in full, especially as the value of the twenty-one succeeding "rules," may be fairly gauged by comparing the first sentence with the last.

"These rules and regulations are drawn up not only for the guidance and instruction of those who have electric lighting apparatus installed on their premises, but for the reduction to a minimum of those risks of fire which are inherent to every system of artificial illumination.

"The chief dangers of every new application of electricity arise mainly from ignorance and inexperience on the part of those who supply and fit up the requisite plant.

"The chief element of safety is the employment of skilled and experienced electricians to supervise the work."

Now, it is necessary to examine these sentences closely, for wittingly or unwittingly the value of all the rest depends upon what they really mean. Does the first sentence mean that "those who have electric lighting apparatus installed on their premises" may—guided by the said rules and regulations—reduce to a minimum those risks of fire inherent to the *electric system?* If so (which seems obvious), then the rules and regulations are, or should be, so explicit that the last sentence grossly exaggerates the importance of "employing skilled and experienced electricians." For the rules being so clear and adequate must obviate the necessity for skilled experts. The second sentence at first sight may seem to be intended as a simple antithesis to the last, but a closer examination will show that the three sentences quoted refer severally to three parties that would ordinarily have a hand or a voice in any given installation of an electric light plant, the ultimate meaning of the three sentences being that any user of electric light, if guided by the said rules, will require that the men who fit up the apparatus shall do so under the supervision of electricians of well-known experience and skill. There are other ideas, however, intentionally suggested—to wit, that *all* systems of artificial illumination involve fire risks greater than those of the electric system; that *all* new applications of electricity are subject to failure through the "ignorance and inexperience of those who supply and fit up the requisite plant; and that there are skilled and experienced electricians who can reduce all risk of fire or other form of failure to a minimum by their counsel or supervision." If this be so, who are the skilled and experienced electricians who can protect the public if they will be guided by this committee of eighteen? If any true system of selection can be suggested by the committee it will be a public service to mention it, but meanwhile we are compelled to be content with what little light the society's electric light rules throw upon the matter. Before analysing these rules, however, let me state a parallel proposition to that contained in the second sentence of the preamble, as it will qualify the disposition to obedience in the use of any of the rules that are too vague and arbitrary for serious consideration. My proposition is that all new applications of electricity are subject to failure in consequence of the fact that the varied practical exigencies for public utility are far beyond the range of lecture-room experience; and when these lecture table experts are brought face to face with practical difficulties outside their sphere of observation and study, they persist in using lecture room spectacles to find out the cause, and in prescribing a remedy they seem to take the immediate elements of the problem and lay them on the lecture table before they commence their diagnosis. This, I assert, is the kind of mental attitude which alone will account for the greater part of what the committee dictate for the "guidance and instruction" of us practical men. Consider, for example, what a comprehensive but false statement is contained in the third sentence of the preamble:—"The difficulties that beset the electrical engineer are chiefly internal and invisible, and they can only be effectually guarded against by 'testing' or probing with electric currents." It ought by this time to be well known, *even* to the "upper crust" of electrical science that no amount of "testing or probing with electric currents" is of the slightest use to *guard against* the difficulties in question, for the next sentence proves that it is only one incidental category of difficulties that such a sweeping proposition can apply to. For it says, "They depend chiefly on leakage, undue resistance in the conductor, and bad joints, which lead to waste of energy and the production of heat." It is, therefore, *only to find out the evils* in an *existing* electric plant that the "testing" process is good for *not to* "*guard against*" such similar occurrences in new plant, or even their recurrence in old plant. But the committee mean on this point exactly what they say, for it is a surprising, though a well-known fact, that the majority of men go to fix electric conductors armed with a galvanometer, on whose indications they rely with child-like confidence. Now, to use a galvanometer for the verification of the condition and suitability of any *new* electric light wires for permanent use indicates a great ignorance of the nature and extent of the "wear and tear" that they will probably be subject to, and the following sentence of the preamble proves that the committee had but a very hazy idea as to whether the same "guidance and instruction," which would be suitable for laying new wires, would also apply equally well for the detection and repair of faults in old ones. The sentence runs as follows:—"They (the difficulties) depend chiefly on leakage, undue resistance in the conductor, and bad joints, which lead to the waste of energy and the production of heat." Now, the leakage can very rarely be detected, even if the media exist, until some time after the plant has been established. Therefore, how can the difficulty be "*guarded against*" by "testing" or "probing with electric currents."

A sufficiently powerful current to completely cut through any of the wires in a day has been *incessantly* coursing through the (400) wires in the Grand Hotel, Scarborough, for the last fourteen years without rupturing more than three or four branch wires during the whole time, and even so long ago I knew the importance of not allowing any one to use a galvanometer, or any other testing instrument, until the wires were all fixed, which, I need not add, was then unnecessary.

If the scientific committee of eighteen would condescend to be guided by the experience of a few scientific and practical electric bell-hangers, they would have little difficulty in drawing up some sound and serviceable rules. They have nowhere else to look for practical knowledge tested by, or derived from, an extensive induction from facts, involving nearly all the important contingencies to which electric light wires are, and must be, subject.

It is rather surprising that, in speaking of the effects of leakage, one of the most certain contingencies that will produce fire is entirely ignored from beginning to end of preamble and rules, and what makes a reference to it still more important is the fact that in the Phœnix rules a method of fixing wires is sanctioned that must of necessity produce a fire whenever the contingency occurs. But I will refer to this in dealing with the rules. The sixth sentence of the preamble may, perhaps, be considered the most palpable proof that these rules and regulations have been drawn up with so much carelessness that no part can be relied upon, for it contains the judgment of the committee upon a matter that, beyond any other, could be clearly defined in a brief rule, yet *it is not touched upon in any rule.* It is as follows:—

"Bare or exposed conductors should always be within visual inspection, since the accidental falling on to or thoughless placing of other conducting bodies upon such conductors might lead to 'short circuiting' or the sudden generation of heat, due to a powerful current of electricity in conductors too small to carry it."

Now, if the judgment itself is good the reasons given for it palpably suggest exactly the opposite, which might be worded as follows:—Bare or exposed conductors should always be *screened over* "since," &c.

There being several ways of fixing and protecting bare wires that in many cases are infinitely preferable to gutta percha covering, however thick, it is an unfortunate indication of the inability of the committee to "guide and instruct" those whom they address. Space forbids any attempt to make this an exhaustive criticism, I therefore pass on to the next two sentences, which will finish the preamble. The emphatic language will show that there is some knowledge behind the scenes which the committee have either not fully apprehended or have not well digested, to wit:—"It cannot be too strongly urged that among the chief enemies to be guarded against are the presence of moisture and the use of 'earth' as part of the circuit. Moisture leads to loss of current and to the destruction of the

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conductor by electrolytic corrosion, and the injudicious use of 'earth' as a part of the circuit tends to magnify every other source of difficulty and danger."

After this, one would expect to find some stringent rules for "guarding against the great enemy, 'moisture,'" and some description of his form of attack when the moisture destroys the conductor.

The force of the warning also seems to vanish when the *injudicious* use of earth is set up as *the great* "*source* of difficulty and danger." For if it "*magnifies every other source*" the legitimate or judicious use of "earth" ought to be more or less explicitly indicated.

It is, however, refreshing to find that some of the great rulers in the world of telegraphy have begun to speak warily of the use of "earth," but Rule 10 dissipates all confidence in their dictum. As I will point out.

The first six rules apply to the dynamo machine, and may be passed over with the remark that Rule 5 exhibits the weakness of doubt or timidity.

Rules 7 to 18 treat of the wires, and I shall confine my remarks to them.

Rule 7 is sound enough, except that if the first half could be relied upon the second half would be needless. Rule 8 is explicitly contained in Rule 9, which is so utterly inadequate to the range of circumstances, that are not touched upon by any other rule, I pass over with a remark merely on the *nota bene* added to the rule.

Instead of speaking of enclosing the safety fuses in incombustible cases, it would surely be better to require that the section of fusible metal (to melt at, say, 205 degrees Farenheit) shall be longer than any arc that the main current could establish, for it would then be impossible for any dangerous heat to exist for more than a small fraction of a second.

"Rule 10. Under ordinary circumstances complete metallic circuits should be used, and the employment of gas or water pipes as conductors for the purpose of completing the circuit should in no case be allowed."

If the rule applied to *all* instead of only "*ordinary circumstances*," the previous warning about using "earth" would have some force and consistency. But to allow that some extraordinary circumstances justify the use of "earth," and yet in no case to allow the use of a water-pipe return must be thoroughly perplexing to any one who tries to be "guided and instructed" by the committee. The use of a water-pipe absolutely and solely as a return, where an *alternating current is not used*, may in some cases be allowable, but what circumstances favour the use of a non-metallic portion of circuit or real "earth?" To forbid the use of a gas-pipe in any case is reasonable enough.

Rules 11 and 12 are good as far as they go, and not applying to indoors—these rules being chiefly to prevent fire risks—the committee's silence on any other outdoor arrangements need not be wondered at.

"Rule 13. It is most essential that the joints should be electrically and mechanically perfect. One of the best joints is that shown in the accompanying sketches. The joint is whipped around with small wire, and the whole mechanically united by solder."

In this rule there is another instance of loose ideas put into bad English.

Every telegraph engineer knows the importance of good joints, and yet the great point of importance is scarcely hinted at, and no method of securing it is described. *Two* joints are illustrated, both are "whipped around with small wire," but neither of them show the solder. This may be intentionally omitted, and it would have been better to omit all the words of the rule rather than miss the thing intended, which is that the joint should be *not* "*mechanically*," but *perfectly* united by solder. For a joint may be electrically, mechanically, and even *chemically* united by solder, and yet not a sound joint in the sense desired. If there is not perfect chemical cohesion between the solder and the wire, and proper solder to maintain it, it would be better to omit the solder, for there are several ways of maintaining mechanical adhesion that will secure permanent electric continuity much better than the majority of apparently good soldered joints. But, no doubt, every joint in electric light wires should be soldered, although so few adopt a reliable method for want of proper "guidance and instruction."

Rule 14 refers to underground wires, which it scarcely notices because of the presumption that they would not be likely to originate a fire, but there are many circumstances under which they might and would originate fire, for I have seen forty odd wires left with all their surroundings burnt up inside a length of twenty odd feet of casing.

Rule 15. "All wires used for indoor purposes should be efficiently insulated." The committee might as well have said—instead of formulating so many rules—that all electric light wires should be perfectly and permanently adapted to the purpose. What is efficient insulation? And how should it be varied to secure the one great object desiderated under the various condition of local surroundings? If it is all to be left to the opinions or guesses of the electric light engineers whose experience began but as yesterday, then the Phœnix or some other irksome and expensive conditions will act as so much dead weight to block the advance of electric light enterprise.

And whilst insurance surveyors are conjuring up all the imaginable sources of fire risk from electric wires, they as well as the electric experts overlook two of the most likely fire risks. The committee, in their preamble, use the most emphatic terms of warning against the danger of moisture and leakage, but here, in Rule 15, where the methods of guarding against the enemy ought to be clearly indicated, they have not a word of "guidance and instruction" to offer. They leave the one great question to be fought out, craft against capital, between the electric light engineers, insurance surveyors, and the consumer. I pass over Rules 16 and 17 as utterly inadequate to embrace the conditions hinted at, and conclude my remarks on these rules by a reference to the *nota bene* following Rule 17. It runs thus:—"The value of frequently testing the wires cannot be too strongly urged. It is an operation skill in which is easily acquired and applied. The escape of electricity cannot be detected by the sense of smell, as can gas, but it can be detected by apparatus far more certain and delicate. Leakage not only means waste, but in the presence of moisture it means destruction of the conductor and its insulating covering by electric action." The destruction of the conductor by the electric current acting through moisture to the complete dissolution of the wire at a local leak is briefly referred to in the preamble, but the complete operation is not described. Wherever this occurs at the moment of complete severence of the wire an arc light is started. In other words a small fire is kindled. Now, the Phœnix rules explicitly sanction the covering up of the wires with wood capping. The wires must be insulated, of course, but it is a leak arising through a flaw in the insulation that causes the mischief—no matter whether the flaw be a normal imperfection in the insulating material, or a subsequent abrasion or puncture by accident.

Well, supposing this small fire to be originated, it only requires a slight looseness or imperfection in the joint of the wood capping to allow the fire to break out along all the woodwork. In fact, where such can occur in a conductor having the current passing through it day and night, what could prevent the adjacent woodwork catching fire? But this preparation for fire is specifically sanctioned by the Phœnix rules many weeks antecedent to these society rules, and yet not a word of correction on such a radical error. Without waiting for evils to force themselves through all the evasions and interests of craft and capital, why not arrange a public demonstration of all the "accidents" that can happen to imperfect electric light installations? For, if not, how many more such distorted scares may not constantly crop up as that reported in *The Electrician* last month, and copied into the daily papers, to the effect that a certain fire was produced by the dropping of water upon the wire, producing a flaw and a spark, which latter travelled *through the surrounding water to the dry wood.*

As many others, as well as myself, will have lit a candle from a stream of running water, as an experiment in electricity of high tension, the public will naturally infer that such high tension currents are used for electric lighting—but when and by whom? and, if so, why is there no word of warning on such a point in the society's rules?

The emphatic language used by the committee to urge "the value of frequently testing the wires" will remind many of the fools' errands run by many a cable repairing ship.

When the Wheatstone bridge was first introduced to ascertain at what distance a fault might be found in a submarine cable, the first grand "Eureka" that came through the discovered fault to announce the correctness of the "balance" caused many false feelings of security, until it ultimately became known that, if two faults gradually broke out far apart, the indications of "balance" would direct the repairing ship as far away as possible from both faults. Having had to discover thousands of faults in electric conductors no one knows better how "easily the skill is acquired," but I fail to realise much consolation from the fact, either in view of the consumer's pocket or the reputation of *The Electrician.*

Leakage need not and must not be tolerated. The only question is how and how soon will the right methods—for they are several—be adopted.

If I have dealt disrespectfully with the society's rules it is not because I do not respect every member of the committee, whom I know either personally or by repute. One thing I know, and am content with—that is, that what I have written is strictly true, and will bear severe analysis.—Yours &c.,

W. MOSELEY.

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THE BOARD OF TRADE AND ELECTRIC LIGHTING.

To the surprise of almost everybody the Electric Lighting Bill was pushed through Committee of the House of Commons and disposed of at a single afternoon sitting. By the time these lines appear in print the measure probably will have become law. Its unexpectedness may account for the feebleness of the opposition which it encountered. There was no lack of amendments, and some of the arguments against the tendencies of certain clauses rose to the level of grave remonstrance; but nobody thought it worth while to push protest to the trial of a division. Mr. Chamberlain stood to his guns—it is permissible to say guns, we suppose, under present circumstances, even of the junior member for Birmingham—and although he had to be continually on his feet, he never turned his back upon a single line or phrase, much less on any material provision of his original scheme. It speaks well either for the care with which it had been framed, or for the weakness of the case set up by its critics that legislation dealing with interests so vast and complicated was carried through in so short a time, and without a single alteration.

In all probability, however, the choice of the day had something to do with Mr. Chamberlain's success. The direct representatives of opposing interests were there in force, and, had the occasion been an ordinary working day—or, more correctly, an ordinary talking day—they would have picked up a host of voluble supporters. But Saturday is a solemn fast, occasionally set apart only for the doing of real business; and the majority of those present had come to deal with business of far more importance, in their estimation, than that of electric lighting. They were prepared, therefore, to vote steadily with the President of the Board of Trade, in order to arrive at the next order of the day. In the face of these impatient gentry from the north country, champions of gas interests shrunk from a serious contest. Except for the circumstance that Scotch affairs stood second, and not first on the paper, the Electric Lighting Bill might have been abandoned altogether for this present Session.

We have criticised the Bill at some length on a former occasion, and it is satisfactory to observe that our objections to some of its provisions have been shared by persons best able to judge. Mr. Chamberlain's assurance that no injustice is likely to be done under the acquisition clauses contributed to their being passed intact; but we fear it will have no weight in a court of law if ever litigation arise between corporations and companies. The compromise entered into as regards the term of years, was, like all compromises, not particularly satisfactory to either party; and it must not be assumed because "all the leading companies with one exception" agreed to it that therefore they approved of it. On this, as on several other points, it was plainly a case of that or nothing. The President of the Board of Trade is something more than a politician; he had made up his mind what was best for the municipal and corporate bodies, and on a subject of that sort the gentleman who has the responsibility of ancient Birmingham on his shoulders—or perhaps it would be more correct to say has Birmingham at his back—was not in the least likely to yield to the demands of upstart undertakings seeking an opening for new business. He made his terms, and as there was no choice but to accept them, all we can say is that the electric lighting companies should be cautious in striking their final bargains.

The powers of the Board of Trade under the Bill are something quite unprecedented. This is not surprising when the person in charge of the measure is virtually the Board of Trade himself. Nobody knows for certain what that important Department is, but everybody seems to know who it is. It is not the Archbishop of Canterbury, or Mr. Ruskin, or the Poet Laureate, who, any or all of them, may, for aught we know, be official members of the nominal Board. The real Board of Trade is the President for the time being; and when, as at present, its parliamentary head has no mind to to shirk responsibility the result is somewhat startling. His power grows with his opportunities of legislatively enlarging the board's jurisdiction. In the case before us the powers conferred by the Act upon this personal impersonality are almost unlimited. They can grant a license to any local authority to supply itself with electric lighting without the interposition of Parliament; and if the local authority decline to seek a license, they, the Board, can seek from Parliament a provisional order licensing a company over the head of the local authority. Seeking means obtaining when, as is always the case, the President of the Board is a member of the Government in power; and thus all things tend to enable him to do exactly as he pleases with every corporation in the country, and,

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practically, also with every electric lighting company. This is, perhaps, as it should be. We hope it may be so; but we only give expression to a general feeling when we say that, had the *de facto* Board of Trade been a trifle less intimately identified with municipal interests, the operation of the Bill would have been looked forward to with far more hopefulness.

As regards the licensing of local authorities, the general impression appears to be that they will avail themselves of the power rather than allow the work to be undertaken by licensed "companies or persons." A question here arises which is of considerable importance to investors in speculative companies. What is to prevent a corporate body from making as well as using its own electric light? Innocent people who imagine they have contributed to purchase what is called a concession or license for certain geographical districts, and think such concession secures them a monopoly, will find themselves grievously disappointed. Concession will not prevent competition, it may even tend to increase competition; and in any case corporations are not merely free to use whatever system they choose, but are also at liberty to devise a system of their own—a by no means impossible feat, seeing how easy it is to imitate patented rights, and how hard it would be to sustain them if challenged. Much will depend upon the moderation, therefore, of the proprietors of existing electric lighting systems; and we trust that our warning may not pass unheeded. One thing, at all events, is certain, that the new school of politicians is stedfastly set against the creation of any new vested interest. Fat corporations are doomed; and, consequently, this new enterprise for supplying the community with an improved system of illumination will have to content itself with the lean profits of the work-and-live, not of the tax-and-thrive, kind.

BROOKS' SYSTEM OF INSULATION.

In our Volume VII., p 181, we gave the results of experiments with this system as used by the Telegraph Department here. We are informed that some further and very satisfactory results have been obtained in America. A cable of thirty conductors placed in an iron pipe 1¼in. diameter has been laid from Cable House, Jersey City, to the Western Union office in New York, a distance of nine miles and a quarter. The exact results we must reserve for a future number, as our correspondent was not able to obtain them previous to sending his letter. The following practical results may, however, be taken as correct. On No. 30 conductor a duplex system was worked with a dynamo of 185 volts E.M.F. in New York, and 60 cells of gravity battery at Newark. The total length of this circuit was ten miles and a half, including one mile of river cable across North River, and a quarter of a mile of gutta percha covered wire underground to the New York office. The duplex worked perfectly. Telephones were also tried during the working duplex from Jersey City to Newark. Using any two of the other wires for the telephonic circuit the interruptions of the dynamo were scarcely audible, nor was there any perceptible disadvantage in using an earth return. Perfect silence was required to enable the listener to distinguish the sounds due to interruptions of the dynamo. Interrupting a circuit of nine miles and a quarter with 20 cells of Callaud's gravity battery produced little effect on the telephones either with partial or complete metallic circuits Conversations with ordinary telephones were perfectly audible while the dynamo was in operation. With a Blake transmitter, and speaking with the ordinary voice 4ft. from the mouthpiece, the transmission was perfect. We have always been favourably impressed with the value of Brooks' system generally for telephonic and local telegraphic operations, and we are glad to see that the time is approaching when it seems probable that the system will be tried on an extensive scale.

ELECTRICAL ACCUMULATORS OR SECONDARY BATTERIES.*

BY PROFESSOR OLIVER J. LODGE, D.SC.

(CONTINUED FROM PAGE 208.)

No. VI.

So far we have only considered in the roughest and broadest manner the chemical action going on in a Planté or Faure cell, but to understand all the details of their behaviour it is necessary to investigate these actions very closely. In this study we shall be greatly assisted by an excellent memoir of Messrs. Gladstone and Tribe, which is to be found in *Nature*, January 5th and March 16th, in *The Electrician*, March 25th, and doubtless also in other places. A letter of Professor A. S. Herschel, in *Nature*, February 16th, is also of great interest.

As a preliminary the reader is recommended to try a few experiments with two simple lead plates, say about the size of a finger. Scrape them both bright, and immerse them in ordinary dilute sulphuric acid as mixed for charging batteries, supporting them by some convenient arrangement which will hold them steady and vertical, and permit either of them to be withdrawn and reinserted easily without disarranging the wires.

First connect them with a single Grove cell, and you will see a few minute bubbles of hydrogen rise from the plate connected with the zinc, while that connected with the platinum is slowly coated with a white crust of $PbSO_4$. In about a minute the current will be very much weaker, and no bubbles will be noticed, and presently all action nearly ceases. The discharge current which can be obtained is exceedingly weak and practically *nil.* No peroxide is formed with the EMF of one Grove, which, as is well known, is unable to decompose water.

Now put on two Grove cells instead of one. Immediately bubbles of gas rise from both plates. The darkening of the + plate shows that some peroxide is being formed, and in a few seconds a discharge current can be obtained from the two little plates sufficient to ring a bell. It dies away very rapidly, however, and requires a fresh application of the current to resuscitate it.

One may note in passing that it was by no means essential, or even helpful, to the success of this second experiment that the first should have preceded it. If two cells are joined up at once to the clean plates, without first clogging one of them up with $PbSO_4$, the same things go on, and perhaps rather more easily. If a preliminary coat of sulphate has been allowed to form for a long time it exerts quite a serious clogging action, by reason of its want of conducting power.

Another experiment of Gladstone and Tribe's is this:—Immerse the plates in plain water—or salt and water—and act upon them with twenty Groves if you like; no peroxide will be formed, but only hydrated protoxide, which refuses to give an appreciable counter current.

One more experiment—this time Professor Herschel's. Having charged the two lead plates with a couple of Groves properly, remove the hydrogenised plate, insert in its place a bit of clean lead, and try for the discharge current. It is very weak, and can scarcely ring a bell. Remove the clean and replace the hydrogenised lead, and a strong bell-ringing current is obtained for a few seconds, but it stops suddenly. Why does it stop suddenly? Modify the experiment by

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immersing only half the charged surface of the plates when you are going to discharge, and as soon as the bell stops depress one of the plates more, so as to bring a fresh surface into action. It will be found by depressing the + plate that a fresh surface of peroxide does no good, showing that that is not what is exhausted; but a fresh surface of hydrogenised lead (*i.e.*, depressing the — plate) rings the bell again instantly. The current stops, therefore, as soon as the hydrogen is exhausted. It is not correct to say the current stops though, but it is suddenly and seriously weakened; clean lead and peroxide do not give a powerful E.M.F.; the current from clean lead and hydrogenised lead is nearly as strong in the opposite direction.

A further experiment is instructive. Having peroxidised a lead plate, insert it in a beaker of acid in opposition to a a plate of platinum, and connect them both with a galvanometer. It will be found that the current sets out from the lead, showing that even platinum is electro-positive to peroxide of lead. If the platinum has been alloyed with hydrogen the current is strong, but if it is clean the current is still perceptible without a very delicate galvanometer.

If, instead of hydrogenised lead, we try zinc, we shall find a strong current; and it appears that hydrogenised lead and zinc are almost equal to one another at first, though the hydrogen gets exhausted, while the zinc does not. Doubtless amalgamated zinc keeps itself permanently coated with a layer of hydrogen. Amalgamating metals seems to make the layer of hydrogen adhere better, and even amalgamated copper acts extremely well if it has been charged with hydrogen. Indeed, as long as the hydrogen lasts, it is scarcely inferior to zinc or hydrogenised lead. A curious thing, however, is that clean copper opposed to peroxide of lead gives a bell-ringing current much stronger than clean lead, and nearly as strong as hydrogenised lead does. This, of course, is the foundation of Sutton's cell.

All these experiments show the high value of peroxide of lead as the electro-negative element of a cell. Peroxide of manganese is very good, but peroxide of lead beats everything with which I am acquainted. In order that any of these oxides may act in this way, it is, of course, necessary for them to be in good metallic contact with the electrode, so as to form its real surface.

We can further learn from the first three experiments that peroxide is not formed on the + plate until there is a visible evolution of oxygen gas; and one becomes convinced that its formation is due to some secondary action.

The action is probably this: Of the SO_4 liberated against the + plate, some combines with it, forming $Pb\ SO_4$; but the whole is not thus consumed, if it is liberated sufficiently fast, and the rest decomposes the water, liberating oxygen, and forming free sulphuric acid. Of the oxygen atoms so liberated, some unite into molecules of oxygen, others into molecules of ozone; and perhaps all this escapes as gas. But another portion liberated in contact with $Pb\ SO_4$ acts upon it thus: $O + Pb\ SO_4 + H_2O = Pb\ O_2 + H_2\ SO_4$, making some more sulphuric acid and also peroxide of lead. Another portion of oxygen may very likely attack the lead itself in its nascent state, peroxidising it directly; and perhaps it is the ozone which is active in this manner.

It is, therefore, not easy to say exactly what goes on at the + plate, though the broad facts are these—that some sulphate of lead is certainly formed, being visibly white; that as soon as oxygen gas is liberated some peroxide is formed; that some of this peroxide is in such close conducting contact with the lead plate—see above—as to justify the belief that it is formed by direct oxidation; that the sulphate of lead itself gets ultimately, though slowly, peroxidised; and as sulphate of lead is a non-conductor it can only be acted on by secondary action, as explained.

At the — plate nothing particular goes on. Hydrogen is liberated against it, and partly clings to it, but mostly escapes as gas. If the clean lead surface has stood in the acid a short time before charging, it would load itself very slightly with $Pb\ SO_4$; but this substance does not appear to be easily reduced by the hydrogen, and it is seen to fall off as a faint white filmy descending current.

ON ROTARY POLARISATION BY CHEMICAL SUBSTANCES UNDER MAGNETIC INFLUENCE.*

BY W. H. PERKIN, F.R.S.

A short time since, whilst working with the isomeric methylcoumaric acids, I was induced to examine some of the physical properties of a few of their derivatives side by side, and, amongst others, the power possessed by their ethers of rotating the plane of polarisation when under magnetic influence. Still later I made similar experiments with the methyllic and ethylic ethers of citraconic and mesaconic acids. The results of these observations showed that the corresponding ethers of these substances, although of the same composition, and, apparently, the same chemical constitution, gave somewhat different measurements, the more stable bodies giving the higher numbers. Since Faraday's discovery of magnetic rotary polarisation in 1845, numerous experimenters have worked in this direction, but it will not be necessary for me to enter into the history of the subject, as it has already been so ably given by De la Rive (*Ann. Chim. Phys.*, 1868, 15, 57), and Becquerel (*Ann. Chim. Phys.*, 1877, 12, 1), in their important memoirs. So far as the subject has been studied by previous workers no definite relationship between the chemical composition of substances and their power of rotating the plane of polarisation when under the influence of magnetism has been observed. Having already worked a little on this subject, I was induced to extend my experiments, and try to discover if possible whether any relationship of this kind existed. The apparatus I employed was similar to that used by Becquerel (*Ann. Chim. Phys.*, 1877, 12, 12) except that the magnet at my disposal was not nearly so powerful. I generally used tubes about 10 cm. in length, closed at the ends with glass plates, to hold the substances under examination, the ends of the tubes being inserted a short distance into the perforations in the armature, as proposed by De la Rive. Water and carbon disulphide were used as standards, observations being usually made with one of these before and after the examination of any substance, so as to correct for any alteration in the power of the magnet during the experiment. In calculating his results De la Rive took the relationship which he found to exist between the magnetic rotary power of a body and that of distilled water, which served as unity, and called the numbers thus obtained the specific rotatory power. Becquerel, on the other hand, took carbon disulphide as unity, and then further calculated out the result in connection with the index of refraction of the body. The results I have obtained agree pretty closely in most cases with those of De la Rive and Becquerel, but seem to bear little or no relationship to the chemical composition of the substances examined. It was, however, soon seen that by calculating the differences between the magnetic rotary effect of unit-lengths of fluid bodies no useful result could be expected. Take, for example, the examination of bodies belonging to the homologous series. It is evident that, as one ascends in the series, the effect on a unit-length for the addition of $C\ H_2$ in the molecular composition would become smaller and smaller, and consequently the difference in the measurement, if differing regularly with the composition, would decrease in the same way, and this is seen to be the case. Thus, in the measurement of the iodides of the alcohol radicals (compared with water as unity) the difference between methyl and ethyl iodide is about 0·334, whilst that of ethyl and propyliodide is about one-third lower, viz., 0·227. From a chemical point of view it is, therefore, evident that a comparison of unit-lengths of fluid bodies cannot show any clear relationship to their chemical composition. This, however, would not be the case if unit lengths of vapours were examined, because they would be occupied by equal numbers of molecules. Becquerel has devised a beautiful and elaborate apparatus for the examination of the rotary magnetic power of gases (*Ann. Chim. Phys.*, 1880, 21, 289), which will give an idea of what would be required for the examination of substances in the state of vapour. It will be seen that, from its dimensions and the

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difficulties there would be of keeping up uniform temperatures, &c., in such an apparatus, it would be almost impossible to examine the greater number of bodies in the state of vapour. It is possible, however, to refer the results of the observations obtained by the examination of unit-lengths of fluids to the lengths of columns of liquids, which would be formed by the condensation of unit-columns of their vapours, in other words, to lengths related to each other in proportion to their molecular weights, making the necessary correction for difference of densities. This may be found by the simple formula $\frac{r \times M\,w}{d}$, r being the rotation observed, $M\,w$ the molecular weight, and d the density. This calculation having been made both for the substance under examination and also for the standard with which it is to be compared, it is only necessary to divide the result obtained from the former by that of the latter, and the result will be the "molecular co-efficient of magnetic rotation," or, more briefly, the "molecular rotary power."

On calculating out the results of experiment in this way, taking water as unity, the numbers obtained clearly indicate that the molecular magnetic rotary power of bodies follows with the chemical composition in a regular, or comparatively regular, manner. This will be seen from the results I obtained on the examination of the iodides of the alcohol radicals.

Substance.	Molecular Rotatory Power.	Diff. for CH_2.
Water	1·00	
Methyl Iodide	9·07	
		= 1·12
Ethyl "	10·19	
		= 1·20
Propyl "	11·39	
		= 2·00 = 1·0 × 2
Amyl "	13·4	

The molecular rotatory power of ethylic iodide, calculated from the average of two of De la Rive's measurements, is 10·1 (*Ann. Chim. Phys.*, 1871, 22, 12 and 18). From this table it will be seen that for every addition of CH_2 there is a variation of from 1·0 to 1·2.

Fortunately Becquerel has examined a corresponding series of alcohols (methyllic excepted) to the above (*Ann. Chim. Phys.*, 1877, 12, 37). De la Rive has examined ethylic and amylic alcohols. I have also examined methyl and ethyl alcohols. The molecular rotatory powers of these bodies, calculated from these various results, are as follows, water being taken as unity:—

	Becquerel.	De la Rive.	Perkin.	Average.	Diff. for CH_2.
Methyl Alcohol	—	—	1·62	1·62	
					= 1·06
Ethyl "	*2·64	2·78	2·63	2·68	
					= 1·06
Propyl "	3·74	—	—	3·74	
					= 1·14
Butyl "	4·88	—	—	4·88	
					= 1·12
Amyl "	6·06	5·95	—	6·00	

In this series we therefore find that the difference for CH_2 is practically the same as for the iodides, and even within smaller limits.

Some time since a specimen of amylene was examined in reference to its magnetic rotary power. This substance is of interest in connection with the above results, because C_5H_{10} represents $CH_2 \times 5$. The molecular rotatory power calculated from the numbers obtained is 5·87. This, it will be observed, is only a little in excess of the value of five times CH_2, which, taking an average of the above numbers, would be 5·5.

Some slight differences besides experimental errors most probably exist in the numbers given in the foregoing series, arising from the fact that all the bodies examined are not primary ones. The iodide of amyl used, for example, was the iso-compound, and it is most probable also that the butyl and amyl alcohols examined by Becquerel were likewise the iso-compounds.

* In Becquerel's Paper there is evidently a misprint, ethyl alcohol being called methyl alcohol.

De La Rive first showed that isomeric and metameric bodies gave somewhat different rotation when under magnetic influence. In his paper already referred to he gives the results he obtained on examining amyl alcohol (iso ?) and Würtz's amylene hydrate, and he found the latter to give a slightly lower number than the former. The molecular rotary powers calculated from his numbers are as follow:—

Amyl alcohol	5·95
Amylene hydrate	5·81
	0·14 diff.

Judging from this example the results given in this paper are not very seriously affected by some of the bodies belonging to isomeric series.

I have noticed the effect of isomerism or magnetic rotation by examining the chlorides of ethylene and ethylidene, the latter giving the lower number. This part of the subject is of considerable interest, and will require careful study. As mentioned in the commencement of this paper, the so-called physical isomerides differ slightly in their magnetic rotary power.

With reference to the aromatic series of bodies, little as yet has been done, the only measurements of definite bodies which have been published are those of benzene, toluene, and xylene, by Becquerel. I have also examined these and other hydro carbons, but I do not now propose to discuss this subject, as I feel the facts at present known are too few to generalise from. The study of the aromatic series, however, promises to be of considerable interest. So far as experiments have been made, considerable differences appear to exist between orthometa and para-compounds, and until this part of the subject has been investigated very little can be done in other directions, such as the replacement of hydrogen by alcohol radicals, &c.

I have lately obtained a more powerful electro-magnet, and propose continuing my experiments in the different directions indicated in this paper, as it appears that results are likely to be obtained which will be found of practical value to chemists.

Electric Light at Bombay.—At a meeting of the Bombay Town Council, on the 16th of last month, a letter was read from the municipal commissioner, Mr. E. C. K. Ollivant, with reference to the lighting of the Crawford Markets in the city, from which we make the following extract:—"For some time past the Eastern Electric Light and Power Company have been lighting the A. Crawford Markets experimentally, in order that the Bombay public might have an opportunity of seeing how far the electric light would be suitable to this city. The result of this lighting has been an undoubted success, and it has been much appreciated by the stallholders, and the persons frequenting the markets, as it has obviated the necessity, which previously existed, of keeping dirty oil lamps upon the stalls. It is now necessary to remove the temporary connection with the markets, and the company asked to be allowed to light the buildings permananently from their new factory at Mody Bay. To light the markets permanently fifteen lamps are required, at a cost of Rs. 40 per mensem each, or Rs. 600 a month, the cost of all appliances and fittings being borne by the company. The present provision for lighting the markets is Rs. 550 per mensem, but of this only about Rs. 150 are spent on the Crawford Markets exclusive of the gas for the clocktower and the new shops. A further grant of Rs. 450 a month will therefore, be required for lighting with the electric light, and I hope the Town Council will agree with me in thinking that this provision should be made at once." After some little discussion a resolution was carried to the effect that "the municipal commissioner be authorised to enter into a contract for two years."

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ON THE FUTURE OF ELECTRIC LIGHTING.*

BY ST. GEORGE LANE-FOX, ESQ.

During the last few years, and more especially during the last few months, electric lighting has made very great and remarkable progress. But great and remarkable as this progress has been, I do not think that it is to be compared to the advance that is likely to be made in the immediate future. I shall not, however, in the few remarks I have to make, pretend to withdraw the veil entirely from that future. The subject is too vast and too complicated for me; much of it must be left to the imagination of my audience. I shall content myself with indicating the mode in which I think light will come to be produced by electricity, and I shall begin by replying to one or two pertinent questions which the public are ever asking with respect to it.

They say, first of all, "Shall we ever have the light in our houses?" Next they say, "Shall we have to produce the electric current ourselves?" And thirdly, they ask, "Will it be cheaper, or even as cheap, as gas?"

I shall endeavour to answer those three questions. I think I may say at once that we are now in a position, from our knowledge and our experience, to answer them all in favour of electricity. There is not the slightest doubt in my mind that we shall have the light in our houses; and, on the other hand, it will not be necessary that the consumer should supply himself with the electric current, any more than at the present time he is obliged to supply himself with gas. It would, however, be just as possible for him to do so. The third question is one which involves a great many considerations, but I think I can answer it also affirmatively; indeed, I have no doubt that electric lighting will be cheaper than gas. I will now, if you will allow me, give as nearly as possible the reasons which have brought me to those conclusions.

And first, as to the light and the devices made use of for its production. The light itself, by an important modification of the mode of its production, has lately undergone a great improvement. People, speaking of it hitherto, have usually supposed it to have certain inalienable qualities, and some of them very bad ones. They have supposed it to be brilliant, dazzling, flickering, changeful of hue and intensity, unbecoming to the complexion, and so on; in fact, having many qualities making it unsuitable, if not for signalling, or wide open spaces, yet for domestic use. But in so describing the light they have, I think, had in their minds the so-called "arc" light only. Now the arc light has done very much for the progress of electric lighting, and what I am about to say may seem strange and ungracious, but it is, I believe, nevertheless true, that in a short time the arc light will be altogether superseded by the more modern and much more convenient "incandescent" light. I may pause here to point out the impropriety of those names. In all cases light, when produced by electrical energy, is due to incandescence. However, the names have now got a current and popular meaning attached to them, so I will not attempt to further meddle with them here. To proceed, the so-called "incandescent" light has none of the disagreeable characteristics of the "arc" light. It is not too brilliant nor too dazzling; it requires no shade to temper its use; it is not either flickering or changeful of hue or of intensity, and it is not unbecoming to the complexion. In the "arc" light, the light is produced in the open air by an intensely-heated and variable gaseous conductor, composed in part of the common air and in part of vapour of carbon, playing upon and between the points of two carbon pencils, the points of the pencils being, by the action upon them of the gas, raised to a very high degree of incandescence. The gaseous conductor is heated by the electric current passing through it from one carbon pencil to the other. In the "incandescent" light so-called, the light is produced in vacuo by the action upon an invariable solid conductor, generally a filament of carbon, of an electric current kept at a constant pressure. It will be seen that the conditions of the two lights are entirely different, and that in the case of the "arc" light the conditions are such as to make variations in the quality of the light produced almost inevitable, whilst in the case of the "incandescent" light the conditions are such as almost to guarantee a light perfectly steady and uniform in its character.

With respect to the device by which the "incandescent" light is produced, most of you are now, no doubt, familiar with at least the outward appearance of the incandescent lamp. It consists chiefly of a glass globe, from which the air has been as completely as possible exhausted, and in which there is a carbon filament mounted on two conducting terminals. Now this sounds very simple indeed, but there are a great many points to be attended to on the part of the manufacturer of the lamp. It is not difficult, and it has not been for several years, to make a good incandescent lamp; but to make a large number of them, so that they are all good and all alike, is quite a different matter. I do not say it is now difficult, because the difficulties are gradually disappearing, but it required a great deal of work, thought, and study, in former times. It introduced altogether new subjects. We have to deal with people other than those engaged in scientific pursuits, and to train them up so as to make them do their work properly. For that purpose we have had to devise a great many means of saving labour, and making it unnecessary that they should think at every stage. I may tell you briefly what the chief points are in the construction of an efficient and durable electric lamp. First, the material solid conductor or carbon filament should be sufficiently strong. Various carbonised substances can be used for the purpose. When I began experiments I used every conceivable material—orange peel, pieces of wood and paper, and vulcanised fibre, and all manner of things. I finally thought it was scarcely possible to get the right material. But by degrees I found that there were other difficulties in the way besides getting the right material. We found we were not getting so good a vacuum as we supposed we were. We thought when using a Sprengel pump, that if the mercury made a clicking sound in the tube, the vacuum was complete. This was, however, no real criterion. The only way in which we can exhaust a globe or glass vessel is by taking the pressure away from the outside, so that the gas, by its natural expansive power, can force itself out. Now, if in the exhausting apparatus we use there is any opposing pressure, due to the presence of moisture, the residual gas, after a certain degree of exhaustion has been attained, has not sufficient expansive power to overcome it, and ultimately an exact balance between the two is arrived at. The highest degree of exhaustion is thus measured by the actual pressure or tension of any moisture which may have found its way into the apparatus. To shut this moisture out of the pump and hermetically seal the junctions of the mercury with the glass and sides of the apparatus, I used sulphuric acid, an acid in the form of a liquid which gives off no vapour in a vacuum. This was the first and most important advance I made towards the completion of the lamp. I was obliged, however, finally to abandon the use of the Sprengel pump and to invent another more adapted for the purpose. My own, I think, is at once more rapid and more effective.

The next point is the necessity of keeping the electric connections between the inside and outside of the globe perfectly hermetically sealed. The only material we can use so as to make a close joint is platinum. There are others that can be used, but not so practical. The difficulty, however, remains that there is still a slight difference between the expansion of glass and that of platinum; the result is that a slight annular space is left between the glass itself and the platinum wire which leads the current into the inside of the globe. I have tried to overcome that difficulty by putting little globules of mercury round the outside of the platinum wire. It gave rise to difficulties at first, but now I think that is very effective in preventing the air passing in between the platinum wire and the glass.

I will not trouble you with any more details of manufacture, but I will call attention to the material out of which the carbon fibre is made. It is the root of a grass known as French whisk. This material is prepared by boiling it in caustic soda, so as to remove the traces of silica which are to be found on the surface. It is then thoroughly washed, and while still damp wound tightly round and tied upon small blocks of graphite. These blocks are buried in plumbago, and intensely heated. By this means a very strong and durable carbon filament is obtained.

The lamp as a whole is exceedingly portable and convenient, and is always quite ready for use. It requires no trimming or adjustment when once mounted in an electric circuit, and it is suitable for use in houses, places of business, &c., as well as in the streets and public places.

We now come to the distribution of electricity, upon which hangs the answer to the householder's question, "Shall I have to produce the electric current for myself?" I hope to be able to show that he will not, and that he will have to think no more about this source of his supply than he has at present to think about that of gas.

As our chairman has just said, a few years ago it was generally believed to be altogether impossible to distribute electricity or the electric current as gas is distributed. A Select Committee of the House of Commons apparently came to that conclusion in 1878; and it is true that at time nothing had been done to demonstrate the contrary, or to show that distribution on a large scale, or a scale similar in every way to the scale on which gas is distributed in the metropolis, was so much as practically conceivable. Now things have altered very much, and there is no longer any doubt that electricity can be transmitted and distri-

* A paper read before the Royal Institution, May 17, 1882.

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buted for every purpose, and in every way as easily, if not more easily, safely, and economically than gas.

I propose to describe briefly a system by which this can be accomplished. But before doing so, it may be well, perhaps, to say a few words upon the modes in which the electric current is generated and sent on its way through the system. Most of you are, no doubt, familiar with that, but in case there are some here who are not, I perhaps may be allowed to explain.

I must begin by calling attention to the difference between electricity and the electric current. The difference may be likened to that between air at rest and air in motion. We very commonly talk of there being no air when the air is only very still; but of course we know there is every bit as much air when it is still as when it is violent motion in the form of a gale of wind. In the latter case, however, the effects are very different, the air when in motion being capable of exercising a very considerable pressure upon whatever opposes itself to its motion. So it is with electricity. When at rest it escapes our observation, when in motion it produces phenomena which are comparable in magnitude and visibility to those produced by the wind. Electricity, indeed, may very well be conceived of as a subtle fluid or gas pervading all matter, and made apparent to us only in its effects, when it has been transferred from one to another, or is set in motion and has been accumulated.

Motion of electricity, or the electric current, as it is called, can be produced in a variety of ways. The most important for our present purpose of electric lighting is by a machine constructed for the purpose, and called a dynamo-electric machine. This machine depends upon a principle discovered by Professor Faraday, and which admits, if not of a simple explanation, at least of a simple description. It is this: if a ring of wire be made to move across a "magnetic field," as it is called, that is the space in the immediate neighbourhood of a magnet, a current of electricity will be produced in this wire, first in one direction and then in the other, according as the ring advances or recedes in crossing the field. This fact is utilised in the dynamo in the following manner:—A wire is wound endlessly upon the rim of a wheel, so that as the wheel revolves the coil is made to cross a magnetic field suitably arranged for the purpose. As this coil approaches the magnetic field, a current is set up in it, and as it recedes this current stops, and another of a precisely similar character, but in an opposite direction, takes its place. No electricity is generated. The electricity is already in the wire. The current, *i.e.*, the backward and outward movement only of the electricity, is produced by the mechanical motion of the coil across the magnetic field. It is almost as if the electricity were the wire itself, and this was set in motion backwards and forwards around the rim of the wheel. It will not be necessary for me to go into this matter more fully. I think if you follow me thus far, that we have in the dynamo-machine electric currents generated in a coil of wire by the revolution of the latter across a magnetic field, you will readily understand how mechanical motion is converted into electrical motion, and how the current itself is comparable in point of movement to the rotation, first in one direction and then in the opposite, of the coil around the rim of the wheel upon which it is made to revolve. The coil of wire is, I may add, elongated so that part of it only actually revolves on the wheel across the magnetic field; the rest, detached, but in free contact with the part that revolves, is stationary, and constitutes the external circuit, as it is called, of the machine or system. It is on the external circuit, variously broken up and distributed for the purpose, but retaining the essential characteristic of the original coil from which it is derived, viz., that it is a part of a coil which wound upon the rim of a wheel revolves across a magnetic field, that the various devices, such as lamps, are arranged for the utilisation of the current in the production of light. I may mention that it is not necessary that this external circuit should be composed entirely of wire. The earth is a good conductor of electricity, and may be substituted for the wire in the return portion of the circuit, when it is not necessary that the current should be preserved from waste by insulation. Returns by "earth," however, have a wider signification than returns by actual earth; they include all returns in which the conductor is uninsulated. There is an important detail in the construction of these machines which I have not mentioned; I feared it would complicate the description. However, my conscience pricks me, and I must now at least briefly refer to it. In approaching the magnetic field a current is set up in the coil in a certain direction. On receding from the field the current is reversed, and proceeds in the opposite direction. Now, generally, it is necessary that this current should, in any circuit in which are devices such as lamps for the utilisation of electricity, proceed always in one direction. This is effected by means of a device called a commutator, whereby as the inner circuit revolves across the magnetic field, now advancing and now receding, the termini of that circuit are brought alternately in connection, now with the positive and negative, now with the negative and positive termini of the external circuit. In this way the current in the external circuit flows always in one direction, whilst the current in the inner circuit flows always, first in one direction, and then in the opposite, in constant and most rapid alternation.

Another important way of giving currency to electricity is by chemical combustion. Batteries constructed for that purpose are of two kinds, primary and secondary. In a secondary battery the chemical condition, which is the immediate cause of the current obtained by its means, is itself produced by the passage through the battery, but in the opposite direction to that of the derived, of a prior current of electricity. The action of this prior current upon the contents of the battery may be likened to winding up a spring, or lifting to a height a heavy weight. The force expended in winding up the spring or in lifting the weight is stored in the new form or position of the spring or weight, ready to come into operation again in the opposite direction the moment it is at liberty to do so. So, in the case of the secondary battery, the prior current which has passed through it has exerted an effect which is stored up in the battery in the form of its chemical equivalent. Given a closed circuit and liberty to act, and this chemical equivalent will revert to its original condition, and a current of electricity in the opposite direction will be the result. This battery, by virtue of its power to store up in a chemical form the energy of a current which has been made to pass through it, and to restore the energy under proper conditions in its original form of an electrical current, is of immense value, and destined, I have no doubt, to play a most important part in the future of electricity. I shall explain by and bye the mode in which I propose to make use of it in my system of distribution.

A primary battery is, at present, of comparatively little value as a source of electrical energy, and it is difficult to see how in the future it can be made to play any very prominent part, so far at least as electric lighting is concerned. In an ordinary primary battery the current produced is far too weak for the purpose, and the requisite strength can be attained only at a most disproportionate cost. I may dismiss this battery, then, with the remark that, as its name implies, it is distinguishable from the secondary, in being a primary source of electrical energy, that is to say, it has already in its composition the conditions requisite for the production of a current, and does not require a prior current of electricity to be passed through it in the opposite direction.

Having prepared the way by explaining the mode in which an electric current of any strength may be produced in a circuit, and the mode in which electrical energy may be stored in a secondary battery, I will now proceed to describe the mode or system by which I propose to distribute the electric current, so that it shall be at all times at the point or points, in the house or in the street, at which its energy is required for the production of light in a lamp such as I have described.

I choose a central station with a due regard to the area over which I have to supply the electric current. I there set up my dynamos. To put them in motion it will be necessary to have one or more steam engines, or a convenient fall of water. My central station, then, will comprise a source of mechanical motion proper to set the dynamos in motion and the dynamos themselves. I have now to distribute my external circuit, the vehicle of the electric current, and to set up at various points of the system the secondary batteries which I have already described. The external circuit in its ramifications will very much resemble the mains, submains, and pipes of a system of distribution for gas, only that the mains, submains, branches, and wires of the external circuit will be solid, much smaller, and, to prevent the waste of the current on its way to the lamps, insulated. A wire, precisely as in the case of gas, will proceed from a main, submain, or branch to each point in a street or house at which it is proposed to erect a lamp. At the entrance into a house, the size of the wire will depend upon the size of the house and the number of lights intended to be used, just as at the central station the size of the mains will depend upon the extent of the area over which it was proposed to distribute the current, and the number of points at which it is proposed to utilise it in the production of light. At the points in a house where the lamps are attached, the wires will be about the size of an ordinary bell wire, and as easily manageable, and, I may add, as perfectly harmless. There is no danger to be apprehended in a properly-arranged system either of shock or of fire. In such a system as I am describing, I should not propose to use a current having a higher tension than, say, 100 volts. And at this tension, or, indeed, as has lately been proved before a Committee of the House of Commons, at a tension of twice that amount, a shock would be absolutely out of the question. And fires in such a system could happen only from what is called "short circuiting," which is perfectly avoidable, and need not ever happen.

I have said that the size of the mains at the central station

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will depend upon the extent of the area over which it is proposed to distribute the current and the number of points at which it is proposed to utilise it in the production of light. That, however, is only true on the assumption that secondary batteries are not made use of as reservoirs of electricity, and that the current is supplied as it is wanted from the central station alone. In that case the whole of the plant at the central station, including the source of motive power and the dynamos, as well as the mains and submains, will have to be adjusted so as to supply the the maximum quantity of electrical energy which may at any time be required in the district. Such an adjustment it is obvious would be proportionately expensive. Moreover, as the engines would be at work only when light was required, and at their maximum very rarely indeed, it is clear that the plant would for a great part of every day and night be lying idle. Another disadvantage attending such a system would be the entire dependence upon the central station for the supply of the electric current. Should any accident happen at that station, so that the engines were thrown out of gear, there would be an immediate arrest of the current, and, assuming the district to be lighted at the time, total darkness would ensue.

(TO BE CONTINUED.)

THE ELECTRIC LIGHTING BILL.

The following letter from Sir Frederick Bramwell appeared in *The Times* for July 21:—

"SIR: I believe that very few of the public, and, indeed, very few of the members of the House of Commons, are aware of the gravity of the principles which are involved in the provisions of the above Bill.

"It is but too commonly assumed that, being a Bill for a specific object, that of electric lighting, its provisions can but little concern those not interested in that lighting, unless, indeed, they be persons engaged in the supply of gas. Such an assumption is, however, by no means warranted, as the principles which underlie the Bill are, I fear, intended to be of very extended application.

"In your leading article of Monday you enumerate the advantages attendant upon electric lighting, as set forth in the evidence of the President of the Royal Society—advantages so great that all must desire to see electricity laid on for domestic use, a desire shared in, I presume, by the Board of Trade, or they would not have introduced the Bill. I feel, therefore, I am entitled to say that the Electric Bill must be taken as intended to give facilities for bringing into practical commercial use a meritorious, but as yet undeveloped, undertaking, and that electric lighting is clearly not to be looked upon as some objectionable thing, which, although it cannot be wholly stopped, should as far as possible be kept down by restrictions; and therefore, I presume, it may be taken as conceded that the Government would not seek to weight such an industry in its very outset by burdens greater than those which it would see fit to impose on other older and fully developed, but certainly not more meritorious, industries. This being so, I fear it follows that the most cruel conditions of compulsory giving up of the undertaking which are imposed in the Bill upon electric lighting will, at the very first opportunity, be imposed in all cases where private enterprise seeks parliamentary powers to enable it to supply public needs.

"In your article of Monday you stated what these conditions are, but let me repeat them. The Electric Bill, by Clause N of Section 14, provides that where the lighting is done by an individual or by a private company, under a provisional order confirmed by an Act of Parliament, then at the end of 15 years the local authority of the district lighted shall be entitled to say that it desires to purchase the undertaking, and thereupon the undertakers shall be compelled to sell. This in itself would be a sufficiently hard provision were the terms of payment fair; but the terms of payment are most unfair, for the arbitrator who, failing agreement, is to fix them is forbidden to take into account in so doing either past profits, goodwill (which means present profits), future profits, or any allowance for compulsory sale; and, having been thus told what he is not to allow, he is directed to ascertain the then value of the land, buildings, machinery, and plant, having regard to their suitability for the purposes for which they are intended, and this is to be the sole payment for the acquisition of the undertaking. Further, if the local authority should not choose to exercise this option at the end of 15 years, then at each recurring period of five years the same option is to rearise.

"As I have said, there is nothing in the nature of electric lighting to justify exceptional harshness; on the contrary, it is regarded with approval, and thus, if there be any exceptions, it is to be supposed they would be exceptions in favour of this useful, desirable, but undeveloped industry. I fear the obvious conclusion to be drawn from the foregoing considerations is that in all future applications to Parliament for a Bill to light a town with gas, or to supply it with water, or to make a new railway from A to B, there will, in the interests of consistency, be inserted provisions that at the end of the 15 years the local authority may buy the gas undertaking at the then value of the 15 years' old pipes and 15 years' old works, that it is to get the waterworks on similar terms, while the railway, extending over the districts of many local authorities, will be doomed to be acquired by the Government for the then value of the land, works, rails, and rolling-stock.

"Is the country prepared for this? Has the time come when private enterprise, which, I believe, has made this country what it is, shall be discouraged, and such undertakings shall pass into the hands of governing bodies, be they corporations, local boards, or the Imperial Government?

"I believe that the making of the governing bodies into traders is one of the gravest of mistakes. Many valid and weighty reasons could be adduced in support of this proposition, but I must not trespass upon your space. There is one matter in which, perhaps, a governing body may be allowed to be interested, and that is in the supply of water. There are two circumstances which render this different from any other kind of supply or trading—one is that it is so unlikely as to be practically impossible that the commodity will ever be superseded, and the other is that on sanitary grounds it is necessary to charge persons for water on the basis of a rate, and not according to the quantity used, just the same as I, living in a moderately good house, pay more for my share of the lighting, the paving, and the use of the sewers than is paid by an artisan deriving just the same benefit from them, so I, living in a house of that kind, pay some 1s. 6d. to 2s. a thousand gallons for all the water I use, in order that the artisan may have the water that he uses for some 2d. to 3d. the thousand gallons. These exceptional circumstances may possibly justify the supply of water by a governing body, although even a water undertaking is, I believe, best conducted when the supply is in private hands and the public body is confined to the supervision.

"One further observation, and then I feel that I must stop, not because that which I have to say upon the subject is exhausted, but because of the length of my letter. It must not be supposed by any of the public who are not conversant with such matters that the mode proposed for assessing the amount to be paid by the local authority for the acquisition of the undertaking is universal or even common. On the contrary, there is not a single instance of such a mode. The only thing bordering upon it is that given in the Tramways Act, 1870, and it would be perfectly easy to show, as I have shown elsewhere, the wide difference that prevails between the case of the tramways and that of the electric light; and, moreover, when it suits the public body to purchase upon income, then pains are taken to make sure that income shall be the basis. Let me refer to the Act of 1877 for freeing the toll bridges of the metropolis, and it will be found there (Section 5) that these undertakings were to be acquired upon regard being had to the net annual value of the tolls. It was well known that the bridges were yielding inadequate dividends. It was well known that had they been acquired for the then valne of the lands and buildings, having regard to the purposes for which they were intended, the sum to be paid would be, in many cases, a very large one—practically that which a new bridge would cost, less the small depreciation. Thereupon care was taken to insure that the acquisition should be upon the revenue. I was engaged in several of the arbitrations, and, among others, in that by which Waterloo Bridge was acquired. This bridge, with its approaches and land, cost £1,050,000 sixty years ago. It would have cost very much more at the present day. Nevertheless, upon a sum arrived at by the capitalisation of the net revenue that bridge was acquired for £475,000. Sir John Hawkshaw stated that the very lowest cost for which the bridge and the approaches could be made at the present day, wholly irrespective of land, was £700,000. Notwithstanding this foreseen result, I, who was consulted by the Bridge Company, felt that no objection could be urged against the principles of payment arrived at by capitalising the revenue. But this, the right principle, has not been followed out in the Electric Bill. There, at the end of 15, 20, 25, and every period of five years after the 15, the local authority watches to see if there is a profit, and if there be, then it comes in and buys, not upon the profit, but upon the materials. If there is no profit, so that it would not be worth while to buy the materials in order to earn the income, then there is no obligation on the local authority to buy at all, and thus in effect the Bill says, 'As long as there is no profit or a poor profit, you, the undertakers, may continue to work, but the instant you get anything like an adequate return, then we will come and buy you up at a

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price which must inevitably be a comparatively small fraction of the capital you have laid out in your undertaking.' I feel compelled to repeat that which I told the committee, 'This is a monstrous proposal.'

"It is on the foregoing grounds, I say, that the passing of this Bill must be looked upon as the beginning of the end of the carrying out of public enterprises by means of private capital.

"With respect to electric-lighting companies, I believe there is plenty of isolated work for them to do, to make a return to their shareholders, but this Bill will deprive the general public of the benefits of electric lighting. The local authorities will not dare to embark in a comparatively unknown undertaking, and private companies will refrain from doing so with these inequitable conditions of payment on compulsory purchase staring them in the face."

THE ELECTRIC LIGHTING CONTRACT AND MAINTENANCE COMPANY (LIMITED).

The statutory general meeting of the above Company, convened in compliance with the provisions of the Companies' Act, 1867, was held at the Cannon-street Hotel on the 24th inst. Colonel R. Raynsford Jackson presided.

The SECRETARY (Mr. F. R. Grigg) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I very much regret that Mr. Martin Smith, the chairman of the Company, owing to a very severe domestic bereavement, is unable to attend the meeting to-day. The directors regret it the more because Mr. Smith has a very large pecuniary interest in the Company, pays great attention to its policy, and has very strong views as to the lines upon which we ought to work. I regret also that the vice-chairman is absent, through being in America. You are aware that this is but the statutory meeting of the Company—a meeting called by the requirements of the law, and that there is usually no business whatever transacted at meetings of this character. The directors, of course, must adhere to that line as regards the transaction of business, but they feel it their duty to explain the course they have pursued hitherto, and the policy they advocate in the future to the shareholders who are present. The directors have not found it expedient to sink the money entrusted to them so far in the erection of electrical installations. They have found that there has been a very great change in the position of the electrical world since they issued their prospectus. There has been an enormous number of new companies created, and the old companies, which at that time had the greatest prominence, have adopted the policy of the formation of sub-companies, giving to those sub-companies the practical monopoly of the use of their inventions. The result is that instead of there being about half a million at the disposal of the electric light companies, as was the case when our prospectus was issued, there is about £12,000,000 of capital at their command, supposing the shareholders respond to all the calls that may in the discretion of the directors be made on them. One result of this change in the position of affairs is that there are a very much larger number of persons prepared to erect apparatus to give the public the use of the electric light, while the manufacturing power has very little increased. Electrical apparatus, therefore, is excessively dear, and its dearness interferes with profitable investment for the purpose of electric illumination. Your directors have, therefore, thought that it would be wiser for the time being to look on and to see whether in process of time electrical apparatus fell in cost so as to enable this Company to buy on such terms as in the opinion of the board would justify the Company investing its money in electrical installations. There can be no doubt that increased competition must necessarily have that effect, but if it should prove not to do so, then the directors, at all events, would possibly recommend to the shareholders the adoption of the policy of one of the latter paragraphs of the prospectus, departing to a certain extent from the lines generally indicated as the policy of the Company, and start manufacturing. If the profit from manufacturing for electrical purposes continues as high as now, that, at all events, would be the right policy of the Company. Then, it is just possible, if we made a commencement of the works and could manufacture for ourselves, we might have some difficulty with the patentees. If that proved to be so a very important question would arise as to whether it would not be the right policy of the Company to obtain control of patents not by giving the extravagant prices which some companies have given for inventions which may or may not be valuable, but on easy terms, which would give us control of the use of such inventions. I am happy to be able to inform you that the capital is intact. 20,034 shares were allotted. No portion of the money so subscribed in consequence has been returned; and making provision for the staff of the Company for some time to come, and the rent of its office, and all expenses incurred, a very small amount per share would meet all the liabilities for expenditure so far incurred by the Company. The delay of the Company in erecting installations has been influenced to a certain extent also by a desire to see what the clauses of the Electric Lighting Bill would be. There is one of these clauses which strikes the directors of your Company as calculated very much to retard the progress of the electric light, and to cause it to cost a great deal more than it ought to the general public—I mean that clause enabling public bodies to take over the property of the electric light companies at the expiration of fifteen years without giving anything for goodwill, and merely giving the value of the works. That seems to me a very unreasonable provision, because the electrical invention as regards the electric light is in its infancy. It is very possible that the first apparatus put down may have to be renewed more than once in fifteen years, and if the companies are to charge the general public in proportion to the costs they incur and the risks they run, the charge will be so great as to prevent the use of that light by the general public. I believe that some of the provisions of the Bill are more calculated to aid gas companies than to develop the electric light. I do not believe that a clause so unjust can continue long in the Bill, and I think when the nature of its operation is fully understood by Parliament we may expect it to be materially altered in the direction of fair play. As to the position of the capital of the Company, if questions are asked me hereafter, I shall be prepared to answer them with the utmost frankness, it being the desire of the board that there should be nothing whatever, under any circumstances, withheld from the shareholders. To complete what I think it necessary to say to you now, I beg to state that the directors have not taken, and will not take any renumeration whatever for their services until the shareholders receive a dividend. You are aware, I think, because the terms of the prospectus explained the fact, that the preliminary expenses have been met by the board, they doing that in consideration of having allotted to them certain founders' shares, only of value to them after the shareholders have received 6 per cent. There is one other subject I may mention before we listen to the remarks of the shareholders, and it is this—that there will be no call made in September. It would be useless to make a call for additional capital when the capital under our control is not employed.

Mr. WHITLEY observed that the prospectus stated that the capital was to be £1,000,000 sterling, there being in addition 3,000 of what were called founders' shares. He held that the general idea of the advertisement was that the 3,000 formed an integral part of the total. Instead of that, however, shares to the extent of only £200,000 capital were issued.

The CHAIRMAN: I think the answer to Mr. Whitley's question is very simple. If the capital had been £1,000,000, the profit on the founders' shares would have been one third of the earnings above 6 per cent. on £1,000,000; but the capital being £200,000, the profit on the founders' shares is one third above 6 per cent. on £200,000. In further reply to Mr. Whitley, he added: If there is no business done there is nothing to receive on the 3,000 founders' shares. They are issued as fully paid up, and have no interest whatever in the business of the Company till the shareholders have 6 per cent.

Mr. WHITLEY: And if you wind up?

The CHAIRMAN: In that case they are worth nothing at all, and all that has been spent by the directors is lost to them.

Mr. T. PORTER thought the shareholders were very much indebted to the directors for the lucid statement which had been made as to the position of affairs. At the same time he did not think the position of the Company was altogether satisfactory. A great number of people were induced to subscribe originally, when it was proposed to call £1,000,000, and it was supposed by them that that capital could be profitably employed. Only £200,000 was collected, however, and a circular was issued on April 8, in which it was stated that the reason for closing the list so soon was that it was desirable to begin operations at once. He himself subscribed with the belief that the board saw their way to invest the money at once profitably—that although they had no contracts, they had every reason to suppose that they would be able to secure profitable work. They now, however, learnt that nothing had so far been done, and that, on the contrary, the prospect of getting work seemed very much worse than before, because the parent companies, having given monopolies to subsidiary companies, an independent company like this had no apparent prospect of getting profitable work. It seemed to him to be a question whether, under the circumstances explained to them, it was desirable to keep the Company going, or whether it would not be better to wind up the matter at once. He did not say this in any hostile spirit to the directors. They had done their best, and nothing could be more straightforward than the statement of the chairman.

Mr. MATURIN thought they all felt disappointed at the original ideas not being carried out, but he was not surprised. Everything connected with the electric light was so uncertain, being in its infancy, but the directors, no doubt, must be as disappointed as the shareholders. He thought that the policy which the chairman had shadowed forth was a very prudent one—of not using the capital in hand till they could do so advantageously. He also considered it very satisfactory to hear that the directors did not intend to draw any remuneration till the Company was paying—a statement which possibly was no more than was to be expected from the gentlemen forming the directorate of this Company. He also gathered that it was the intention to keep down the expenses to a minimum, and that as regarded the expenses incurred, a very small call on the shareholders would suffice to meet them.

The CHAIRMAN: What I meant to say was that a very small amount per share would meet the expenses already incurred, not that there was any intention to make a call for that purpose.

Mr. MATURIN inquired the amount of capital paid up, which he assumed was invested advantageously.

The CHAIRMAN: The money paid up was £39,918. We are deriving an income from that.

Mr. MATURIN, while agreeing that they might have to wind up, held that the time had not arrived yet. Something might turn up, and they might be able to make this a very paying company. Meantime he thought they should reduce the expenses so as to keep them covered by the interest on the amount in hand. That being done and there being no call made it would be seen that the directors were holding the money to see if a good time came for employing it, and he thought this should have weight with the gentleman who suggested the expediency of winding up.

Mr. THOMPSON inquired what money had been returned to any of the subscribers on allotment or at any other time, and why it had been returned?

The CHAIRMAN: The simple answer to that is that no money was returned.

Dr. POCOCK thought the chairman had made the shareholders a very satisfactory statement. He considered that the waiting policy, in existing circumstances, as enunciated by the chairman, showed that the directors had been actuated by great judgment. He believed, too, that it was a policy which commended itself to all thinking men. He had argued to himself that the very fact that they had not called up a large amount of capital was evidence of the undoubted advisability of the course they had entered upon. It occurred to him that they had acted for the protection of the shareholders in not raising more capital than was necessary under the circumstances. As to a company winding up which had scarcely had an opportunity of breathing itself into a state of animation, such a proceeding would really be like childplay. Bearing in mind that they were crippled by the legislation that had taken place—which must be altered—he thought that they should have confidence in the waiting policy which had been advocated by the directors, and which he believed to be the result of careful thought and decided judgment.

Mr. WILSON remarked that when the Company was first started

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prospectus was issued inviting subscriptions for £1,000,000, but subsequently a circular was issued, and it was stated that only £200,000 had been subscribed for—only one-fifth. Ordinarily, when a large sum was invited from the public and it was found that a very small subscription ensued, the directors did not proceed to allotment, and he was very much surprised that that course had been departed from in the case of this Company. He held that under the discouragement ensuing from the proceedings in Parliament it would now be very much better to return the capital which had been subscribed. He did not doubt that the directors would be capable of making a profit by and by, but he did not see when that time was to come, and he for one felt that he could do better with his money than leave it in their hands. He should, therefore, propose ——

The CHAIRMAN: I must inform you that this is not a meeting at which such a proposition can be submitted. The directors will be largely guided in all their acts by what they find out to be the general wish of the shareholders.

Mr. WHITLEY said he differed from Dr. Pocock. He looked more to the amount behind the subscription than the subscription itself. Proceeding, Mr. Whitley was understood to contend that by the Articles of Association and the Memorandum of Association the main object for which the Company had been started was to supply money to those who desired to have the electric light laid on. He thought it would be better to wind up this Company and start a new company for manufacturing purposes.

The CHAIRMAN: I think the shareholders have been extremely fair in the expression of their opinion upon the subject which has been before the meeting. Mr. Porter's remarks were very much to the point. It might be thought if there were no immediate means of finding profitable employment for the money it would be wiser to return the money subscribed to the shareholders. It might, on the other hand, be thought—as expressed by Mr. Maturin—better that we should wait, and watch the progress of events, and see if the policy on which the Company was originally built up is not the right policy; and if circumstances did not so turn round as to enable the board to employ your capital more profitably. The directors' views are entirely in accordance with the second speaker. His expression of opinion is very fair, and there is only one point in his remarks on which I wish to make any comment in an opposite direction. He suggested that the directors should limit their expenditure to the interest to be derived from the money in their hands. As nearly as possible that should be done, but it is not quite possible. It is necessary for us to have a certain number of scientific men looking out and observing what is going on in the electrical world and reporting it to the directors. There is also the rent of the office we occupy. The expenses will come to somewhat more than the interest on the capital in our hands. The amount that the shareholders are already responsible for covers the salary of the engineer for a year, other salaries for six months, and the rent of the offices for a whole year; and if we wait for some time—say for six months—very little additional expenditure will be incurred; therefore, I for my part, and the directors favour the waiting policy. One reason why we did not at once invest your money, as was expected by Mr. Porter, and as we expected ourselves, was that, although we were offered a very great number of installations, when we came to examine the probable results we did not feel justified in investing your money because the profit would not have been adequate. That was a disappointment to the directors, but they explained it to themselves as they have to you to-day, and they think there will be a change in the circumstances, which will enable them to give the electric light with advantage to the public and to the shareholders. In any case the directors will not risk your money. They have no wish at all hazards to carry on the Company. Mr. Whitley, I think, made some observation as to the fact that we asked for £1,000,000, and received only £200,000, and that, nevertheless, we still went on with the Company. I do not see that our receiving applications for £200,000 instead of £1,000,000 altered our position at all. If our policy was right we could carry it out with £200,000 almost as well as with £1,000,000, and if it was wrong, then it is better not to have locked up a larger sum of money. I do not see that the directors were bound, when the subscriptions amounted to only one-fifth of the sum asked for, to return the money, and refuse to proceed with the business of the Company. I do not know of any other remarks which require an answer from me. The directors are, of course, gratified by the confidence in them to which Mr. Maturin, Dr. Pocock, and others have given expression, and it will be their desire, under all circumstances, to retain the confidence of the shareholders, and to act in accordance with their interests; but this being a statutory meeting it is impossible to pass a resolution. The directors, however, have no objection to making use of this opportunity which they have of meeting the shareholders of ascertaining their opinion in an informal manner on one or two points. I will now ask those who think that the policy of winding up the Company is preferable to the policy of waiting to hold up their hands. Counting, he stated, that there were nine. Continuing, he said, those who preferred the waiting policy, which the directors favour, will hold up their hands. There is a very large majority in favour of the waiting policy. Of course what I do is quite informal.

Mr. WILSON, while agreeing in what the chairman had said, that they might do as well with £200,000 as with £1,000,000, said that the difference in the position which arose was this:—If a prospectus were issued, asking the public to subscribe a large amount of money, and that amount were not applied for, if they went to the Committee of the Stock Exchange, they would tell them that the terms of the prospectus had not been literally complied with, and they would refuse a quotation. Any company not possessing a quotation stood in a different position from one which had a quotation, and it was supposed in the case of this Company that they would have a settlement and quotation on the Stock Exchange. Finding, however, that only one-fifth of the amount asked for was subscribed, that was out of the question. In that respect, therefore, there was a very considerable difference between £200,000 and £1,000,000.

Mr. WHITLEY inquired if there were any contracts at all with the public.

The CHAIRMAN replied in the negative.

Mr. WHITLEY: If we have a "waiting policy," may we not be committed to something before we meet again?

The CHAIRMAN: I think I must ask for the confidence of the shareholders. If we were offered installations that would pay we should invest in them.

Mr. PORTER thought they must all be very much indebted to the directors, and he thought they would all be very well satisfied in leaving matters in their hands. He suggested that if in the course of three or four months the directors found they were still disappointed in their expectations of obtaining profitable work, they should call a meeting and ask whether, under the circumstances, it would be well to go on or no.

The CHAIRMAN then desired to take the opinion of the meeting, informally, as to the advisability of the Company going into the manufacture of electrical apparatus, should they not be able to get it at a moderate percentage on the cost.

Mr. PORTER, however, did not think it was all advisable that they should express an opinion on such a subject, but that it should be left entirely to the responsibility of the directors.

The CHAIRMAN stated that if that was the opinion of the shareholders the directors would, of course, take upon themselves the responsibility of acting to the best of their judgment, and give an account to the shareholders at the earliest possible moment afterwards.

Mr. POCOCK observed, in reference to what Mr. Whitley had said, that the directors in such an undertaking must have a good deal of elastic power. They were in an affair which had an immense fortune before it. They could have no doubt that the directors were actuated by feelings which would prompt them to consider the shareholders' interests as well as their own position.

The statutory meeting was then held to consider the following resolution:—"That the regulations of the Company be altered so as to authorise the Company so far to modify the conditions contained in its Memorandum of Association, as by sub-division of its existing shares, to divide its capital or any part thereof into shares of a smaller amount than £10 each, and that thereupon each of the A shares of £10 each comprised in the capital of the Company, stated in the Memorandum of Association, be divided into two A shares of £5 each; and each of the B shares of £10 each, comprised in the said capital, be divided into two B shares of £5 each."

The CHAIRMAN stated that the division of the shares was suggested to them during the progress of the formation of the Company. The change, however, would cause some offence, and in present circumstances he did not see any adequate object to be gained.

A brief discussion followed, and at the suggestion of Mr. Whitley the word "not" was inserted after the word "be" in the first line of the resolution, which, as amended, was carried.

On the motion of Mr. PORTER, a vote of thanks was passed to the chairman and directors, and the proceedings then terminated.

THE INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY (LIMITED).

A half-yearly general meeting of this Company was held at the Cannon-street Hotel on the 25th inst., "for the purpose of obtaining the sanction of the shareholders to the payment of an interim dividend." Mr. George Henderson presided.

The SECRETARY (Mr. Wm. J. Tyler) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, we do not, as you know, issue any detailed report or statement of accounts for this meeting, but I daresay you will be glad to have some information as to what we have been doing for the past six months. I am glad to say that in most departments of our business we have been fairly employed, and can report an increase in sales, apart from cables, of about £33,000 over the first half of 1881. The market price of our staple material—india rubber—has considerably advanced, and to meet this as far as possible we have raised our selling price, though not sufficiently to cover the advance. We are doing a good business with our own Government in the departments of the Admiralty, the War Office, and the Post Office, and we have a share of the business arising out of the increased use of electricity. Of cable construction in the half year we have executed a second contract with the Mexican Telegraph Company, having manufactured and laid for them a cable of about 275 miles as an extension of their system in the Gulf of Mexico. This gave employment to our steamer, the "International," which, after completing that work, was engaged to repair one of the International Ocean Telegraph Company's cables between Florida and Cuba. Early in the year we supplied the West India and Panama Company with 300 miles of cable, and in May the French Government with 140 miles for the coast of Tunis. The French Government continue to employ us both here and in France. At Persan we are manufacturing a considerable quantity of underground cable for it, and at Silvertown we have on hand a second Tunis cable of 260 miles, the laying of which in the autumn will give further employment to our steamer, the "International." The chief work of the year, the Central and South American cable expedition, has proceeded very satisfactorily. The "Dacia" has returned from accomplishing her share of the work, and the "Silvertown," according to our latest telegrams from our engineer, Mr. Robert Keith Gray, is engaged in laying the last section. He expects to have the whole system completed from Vera Cruz to Callao, extending over a distance of more than 3,000 miles, by the end of this present month. The expedition has been conducted hitherto without important accident or serious illness, and all our staff have worked cheerfully and energetically in spite of long hours and much exposure in a trying climate. We hope to meet you again in February with a good account of the year. To-day you are called together chiefly to sanction the payment of the usual ad interim dividend of 5 per cent. Before concluding, however, I ought to mention that on the dissolution of this meeting an extraordinary general meeting will be held for the purpose of electing an auditor, to act in conjunction with Mr. Weise, in the room of Mr. James Cowan, now deceased. I have now merely to move "That an interim dividend of 5 per cent., or 10s. per share, free of income-tax, payable on the 25th inst., be now declared."

Mr. S. W. SILVER: I beg to second that.

Mr. D. H. SMALL thought it must have given great satisfaction to the shareholders to hear the statement which the chairman had made of the work the Company was doing for our own and other Governments. They were also pleased to hear that the Company was doing a very large business, and now that electricity was becoming so much used he supposed

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that that also would be an advantage to the Company. So much work was required to be done in laying cables, in electricity, and other things that he felt sure the Company must go forward with the attention the directors bestowed on their affairs. He thought the shareholders had reason to be satisfied with the position of the Company.

The CHAIRMAN: I am perfectly certain that our manager, Mr. Gray, and staff will do everything in their power to conduct the business properly, and to obtain all the benefit they can for the Company.

The motion was carried unanimously.

Mr. DAWSON then expressed his pleasure at proposing for the vacant auditorship a gentleman who would do the Company "good suit and service." The gentleman had not offered himself, but he was a very large shareholder, had had very great commercial experience, and in early life was an accountant and branch inspector in a joint stock bank. He therefore ought to know something of accounts. He held 216 shares, a fact giving him a considerable interest in the status of the Company. He concluded by moving the appointment of Mr. Abraham Scott as auditor for the current year, in the room of Mr. James Cowan, deceased, with a remuneration of 30 gunieas.

Mr. RANDALL, in seconding the motion, expressed great regret at the loss of Mr. Cowan. Immediately after the last meeting he had a short conversation with Mr. Cowan, whom he had known for some years in connection with the National Bank. On speaking to him after the last meeting he found that he was not in good health, and he invited Mr. Cowan to spend a few days with him at his place. The invitation was accepted, and they had a few very pleasant days together. It was, therefore, with deep regret that he had heard of Mr. Cowan's death.

The CHAIRMAN put the motion, and it was carried unanimously.

Mr. SCOTT expressed his acknowledgments for his election, and said he only hoped he might be able to serve them as well as Mr. Cowan had.

Mr. DAWSON then observed that before they separated there was a duty they owed to the directors—to offer them their best thanks for the talent and ability they had displayed, and the time they had given to the management of the affairs of the Company. He thought that the best proof they could have of that was to see the very little fluctuation in the value of their property. Whatever took place, whether it was war in Egypt or anything else, their property remained very much the same, with hardly any fluctuation. He hoped when they met again in the early part of next year the directors would be able to give them good accounts and a good dividend.

Mr. TREBLE seconded the motion, which was carried unanimously.

The CHAIRMAN briefly replied, and the meeting then separated.

THE METROPOLITAN (BRUSH) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of the members of this Company was held at the Cannon-street Hotel on the 24th inst., Sir M. Kennedy presiding.

The SECRETARY (Mr. Robert Wilson) having read the notice convening the meeting,

The CHAIRMAN said: Gentleman, we are assembled here for a special purpose, to consider, and, if thought advisable, to pass a resolution making alterations in certain of our Articles of Association. Those alterations have been dictated to us by the Committee of the Stock Exchange, and until they have been effected the Stock Exchange will not grant us a quotation. It is very advisable that we should, with as little delay as possible, obtain not only a settlement, but also a quotation, and the only difficulty now in our way is that which we meet to-day to overcome. Very few words from me are, I think, requisite to make you acquainted with the nature and scope of the desired alterations. The first is in Clause 4 of the articles, and its object is to prevent the directors, without the consent of a general meeting, from issuing shares at a discount, and thereby "watering" the capital of the Company. The alterations in Articles 81 and 89 are merely to reduce the time under which the present board hold office from 1886 to 1884. The next alteration is the omission altogether of Clause 85 of the Articles of Association, and the object of that is to secure that all matters of importance which would require the consideration of a general meeting should be discussed in general meeting and thrashed out, and not be settled by correspondence. The omission of Clause 100 has for its object the same arrangement. These are all the alterations. They are not numerous and not very important, and I trust, as they are required by the Stock Exchange, that they will commend themselves to members generally. He concluded by moving a resolution making the alterations to which he had referred.

The DEPUTY-CHAIRMAN (Mr. James Whitehead): I have much pleasure in seconding the resolution, and after what the chairman has said it is quite unnecessary for me to detain you at any length. It will be clear to the shareholders that the suggestions made to us by the Committee of the Stock Exchange are in themselves very reasonable, and that they do not in any way interfere adversely with the value of your property. On the contrary, inasmuch as they will obtain for us probably an early settlement and a quotation, they will immediately enhance the value of our shares in the market. In that way I feel sure that the resolution proposed will commend itself to the shareholders assembled.

Mr. WRIGHT asked the chairman to read the Articles 85 and 100 as they now stood. He also inquired if the board could inform the meeting why it was that the shares, which were at a premium in May last of from 10s. to 15s., were now at 25s. to 30s. discount.

The CHAIRMAN having read Articles 85 and 100 said: With regard to the question as to the value of our shares I really am quite unable to answer that. I suppose that the reason they do not stand at the high premium they formerly did is because they were purchased for speculation. There is no moral reason why our shares should have stood at a higher premium when first issued than they should stand at the discount at which I am told they are now quoted.

Mr. WRIGHT said he thought the board might have some knowledge of some reason for it in connection with the character of the work being carried on, and that they could enlighten him on the point.

The CHAIRMAN: The question now put to me I can answer clearly. I can emphatically deny that the board have any knowledge whatever of any reason for the shares standing at the rate at which they now stand.

Mr. ARTHUR H. ROLLS observed that the shareholders were a little "foggy" as to what the operations of the Company were, and if they could be enlightened on the point, and told what were the prospects of the Company, he thought they would be glad.

The CHAIRMAN: This is not a meeting at which the affairs of the Company generally should be discussed; but I have no hesitation in informing you that the prospects of the Company, which is quite new, are very favourable. We are receiving a large number of orders, we are establishing central stations in different parts of the metropolis, and we expect in due time that we shall do a very good business. We have a very good system—a system which (to refer to an expression employed among scientific men, "the survival of the fittest") will survive in the end. We have an enormous field before us. We have many competitors, it is true, and, no doubt, we shall have to meet with great competition. Still, we have a good system, and a large field, and we have the assistance of a gentleman, Mr. Hammond, who is well acquainted with the mode of pushing a business such as ours, and who is pushing it to the utmost of his ability, and with very great success. Therefore, answering your questions generally (and it would not be advisable to do so particularly), I can say that the prospects of the Company, as far as the board are aware, are quite as favourable as we can expect them to be under the circumstances—that is to say, having regard to the fact that we have not long commenced, and the many difficulties before us. There are difficulties as regards legislation and other things—in reference to what is known as a secondary battery, a very important point in all electric light arrangements. We are taking steps to overcome these difficulties, and when the dark nights come, and we have had a little more time, we shall be doing a very good business.

Mr. BISCHOFF, alluding to Article 4, inquired if the whole of the shares were not already allotted.

The CHAIRMAN: The whole of the shares were applied for many times over, and the whole were allotted. There are a few still unallotted, because certain gentlemen withdrew their applications within the time we thought we should allow them to do so.

Mr. BISCHOFF: Then this alteration in Article 4 is merely to comply with the requirements of the Stock Exchange.

The CHAIRMAN: Entirely. There are 310 shares unallotted. Replying to another shareholder, he added: No shares were allowed to be withdrawn after the allotment except in those cases in which persons who wished to withdraw their shares were legally entitled to do so. He then put the resolution, and it was carried. Continuing, he said: We have now disposed of the special business we are called on to transact to-day, and I may inform you that the first statutory meeting will be held when we meet you again to confirm the resolution we have passed to-day. That meeting will be called at the earliest possible moment. The statutory meeting has to be held within four months of the registration of the company.

Dr. POCOCK, alluding to a pamphlet which had been issued by the directors referring to the advantages of the electric light, observed that they might add that the light was of great importance, in that it did not vitiate or heat the atmosphere. He thought that that was of very great importance. For a large number of individuals it was of material practical value to get air in any special apartment pure. Under the best circumstances he believed that gas was frequently passed unconsumed. Not only that, but the very products of combustion were unfavourable to health. There were a large number of instances when that was unfavourable—particularly in affections of the chest. It was important that the public should be made aware of the immense value of the electric light to their health.

The CHAIRMAN: We are very much obliged to you, and the matter shall receive our attention.

The MANAGING DIRECTOR (Mr. Robert Hammond): I may call your attention to page 12, paragraph 4 (where the matter was referred to).

Mr. POCOCK thought in another issue that prominence might be given to the point in the earlier part of the pamphlet, where attention was called to other advantages of light.—The proceedings then terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES JULY 26.		BUSINESS DONE WEEK ENDING JULY 26. Highest.	Lowest
Anglo-American	49¾,	50¼	50¼	47
Do. Preferred	79½,	80½	80½	77⅞
Do. Deferred	20,	21	20⅝	18⅞
Brazil Submarine	11⅞,	11⅝	11⅝	11⅜
Cuba	9¾,	10¼	10 1-16	9 15-16
Do. Preference	16,	17	—	—
Direct Spanish	5⅞,	6⅛	6 5-16	6⅛
Do. Preference	15½,	16½	—	—
Direct United States Cable	11½,	12	11⅞	11½
Eastern Telegraph	10½,	10¾	10⅛	10 1-16
Do. 6 per Cent. Preference	13,	13½	13 1-16	13
Do. 5 per Cent. Debentures, 1899	102,	107	—	—
Eastern Extension	11¼,	11¾	11¼	11
German Union	9¾,	10¼	—	—
Globe Telegraph and Trust Company.	6¼,	6½	6⅜	6⅛
Do. Preference	12¼,	12¾	12 7-16	12 3-16
Great Northern	12¼,	12¾	12⅜	12⅛
Indo-European	28½,	29½	29	28¾
Mediterranean Extension	2,	2½	—	—
Do. Preference	8½,	9	8 15-16	8 15-16
Reuter's	12¾,	13¼	—	—
Submarine	265,	275	263	266
West India and Panama	1½,	1¾	—	—
Do. 1st Preference	8,	8½	8⅜	8¼
Western Brazilian	6¾,	7¼	7¼	6⅞
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	102,	105	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1¼,	1½	1 7-16	1⅜
Oriental	½,	⅝	9-16	½
United Telephone	11¾,	12¼	12 3-16	10¾

ELECTRIC LIGHT.

Electric Light and Power	¼,	¾	⅝	⅝
Anglo-American Brush	19½,	20½	20⅝	19⅝
Eastern Electric	3,	3½	4	3

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

1453. INTERLOCKING OF RAILWAY TELEGRAPHIC BLOCK INSTRUMENTS, &c., *C. Hodgson, Kilburn.—2nd April*, 1881. 8*d*.

This relates to improvements on patent No. 4170, 1879, and provides against negligence in the use of the instruments, and permits the working in both directions to be carried out with a single line.

2041. APPARATUS FOR CONTROLLING AND LOCALISING ELECTRIC CURRENTS, *L. M. de Bejar-y-O'Lawlor.—10th May*, 1881. 8*d*.

This is a modification in the apparatus described in specification No. 408, 1878, its object being to use a wire such as a telephone wire, so that messages to or from the principal station are inaudible or invisible elsewhere.

2263. APPARATUS FOR EFFECTING ELECTRICAL MEASUREMENTS, *J. C. Cuff.—24th May*, 1881. 6*d*.

This invention relates to modifications in the making of resistance boxes, the principle of which are the use of a sliding contact piece to put coils in or out of the circuit, the arrangement and construction of the coils.

2573. IMPROVEMENTS IN MEANS FOR SUPPORTING AND PROTECTING WIRES, &c., USED FOR ELECTRICAL PURPOSES, *H. E. Newton, London.—14th June*, 1881.—*(A communication from C. A. Hussey and A. S. Dodd, New York.)* 6*d*.

This invention consists in the combination with the curb of the footways of a conduit fixed thereto, which carries the wires for electric lighting or other purposes, whilst branch conduits lead off into the houses.

2606. ELECTRIC ACCUMULATORS, *A. Muirhead.—16th June*, 1881.—*(Not proceeded with.)* 2*d*.

The electrodes were arranged similarly to the lead foil plates in condensers, and could be coated or not with red oxide of lead, &c.

2635. AN IMPROVED FLOATING APPARATUS FOR GENERATING AND CONVEYING ELECTRICITY FOR THE PRODUCTION OF THE ELECTRIC LIGHT AND THE TRANSMISSION OF POWER, *W. C. Johnson and S. E. Phillips, Charlton.—16th June*, 1881.—*(Not proceeded with.)* 2*d*.

This consists of a combination of boilers, engines, and electric machines on board of a suitable vessel, so that the whole plant necessary for generating the electric light can be transported from place to place, and the current led where necessary by cables.

2989. IMPROVEMENTS IN APPARATUS FOR THE TRANSMISSION OF POWER BY ELECTRICITY, *J. Hopkinson, Westminster.—7th July*, 1881. 6*d*.

This relates to the utilisation of a dynamo or magneto-electric machine, in combination with a pulley fitted with a Weston friction clutch, and suitable toothed gearing and tackle, as a means of hoisting and lowering heavy bodies. The dynamo or other electric machine is fitted with the inventor's device for reversing the direction of rotation of the armature which was patented by him on the 21st June, 1879, No. 2481, and 14th November, 1879, No. 4653. This electrical hoist was illustrated and described in our articles on the Paris Electrical Exhibition.

3146. IMPROVEMENTS IN OR APPLICABLE TO THE METHOD AND MEANS OF EFFECTING INTERCOMMUNICATION IN THE LIGHTING AND THE WORKING OF THE BRAKE MECHANISM OF RAILWAY TRAINS BY ELECTRICITY, *G. K. Winter, Norwood.—19th July*, 1881.—*(Not proceeded with.)* 4*d*.

This invention relates to an improvement on the inventor's patent No. 2637, 28th July, 1874, and consists principally in a means for making the joint between the cable and the hook at the end of each side or safety chain more mechanically secure, and also making the electrical contact more perfect.

3169. IMPROVEMENTS IN DYNAMO AND MAGNETO-ELECTRIC MACHINES, *A. M. Clark, London.—20th July*, 1881.—*(A communication from W. Laing, Paris.)* 4*d*.

This invention consists in placing the commutator or current collector of dynamo machines in a box filled with water, thereby obviating heating and sparking.

3238. ELECTRIC CONTACT FOR ELECTRIC CLOCKS, &c., *B. J. B. Mills, London.—25th July*, 1881.—*(A communication from G. Leclanché, Paris.)* 6*d*.

This invention relates to the use of mercury to obtain contact. The contacts are multiple and successive, and are produced in an hermetically closed space.

3301. IMPROVEMENTS IN APPARATUS FOR LIGHTING GAS BY ELECTRICITY, *E. B. Burr, Walthamstow, Essex.—28th July*, 1881. 6*d*.

This consists in a portable gas lighter, consisting of a pole having a battery in a case at its lower end and at its upper a platinum wire. This latter is so connected with the battery that on pressing a spring the platinum is heated to incandescence, wherewith the gas can be lighted.

3346. ELECTRIC SIGNALLING APPARATUS, *J. U. Mackenzie, New York.—2nd August*, 1881. 6*d*.

This invention refers more to fire alarms, and allows all call-boxes to be constructed alike and set to a number, instead of as now each being made different.

3380. IMPROVEMENTS IN APPARATUS FOR DETECTING AND RECORDING THE PASSAGE OR STOPPAGE OF AN ELECTRIC CURRENT THROUGH A CONDUCTOR, &c., *W. P. Thompson, Liverpool and London.—4th August*, 1881.—*(A communication from J. A. Pel, Liege, Belgium.)* 6*d*.

This consists of a registering clock applicable to telephone lines, &c. The action is as follows:—The clock is set going at the correct time, that is with the marker opposite the correct time on the dial. So long as the telephone remains unused, the dial, which is constructed of paper, remains unmarked, but directly the circuit is made or broken, the armature of an electro-magnet actuates a steel spring armed with a sharp point, and causes it to mark the dial, showing the hour and day when the circuit was used. The dial circumference is divided into twelve sections of one hour each, and the pricker is caused to move from the centre to the circumference slightly at the end of each twelve hours, so that the record of each hour and day are kept separate.

3384. IMPROVEMENTS IN ELECTRICALLY-ACTUATED INDICATORS, AND IN TRANSMITTERS FOR CONTROLLING THE OPERATION OF THE SAME, *J. C. Mewburn, London.—4th August*, 1881.—*(A communication from C. H. Pond, New York.)* 8*d*.

This invention consists in improvements in the construction and operation of the electrical indicator invented by C. H. Pond, which was patented on the 28th August, 1880 (No. 3505), by W. Clark as a communication from J. Van Dussen Reed. It also consists in an improved transmitter for use with the indicator by means of which special calls may be sent. The improvements dispense with all but one of the actuating electro-magnets, and a great many switches and other apparatus, besides rendering an indicator of two or more indicating systems capable of working in the line circuit, thereby dispensing with the local battery and relay.

3386. AN ELECRIC ORGAN, *W. F. Schmoele and A. Mols, Antwerp.—4th August*, 1881. 8*d*.

This invention relates to improvements on a previous patent dated 27th July, 1881, No. 3294, and also to a means whereby drums, cymbals, &c., can be played at the same time as the organ. The improvements consist in the method of adapting the levers to operate these instruments.

3412. AN IMPROVED FLUID TO BE USED IN GALVANIC BATTERIES, *T. Coad, London.—6th August*, 1881.—*(Not proceeded with.)* 2*d*.

The fluid used is a hot saturated solution of nitric acid, bichromate of potash, and nitrate of potash, to which is added one-fourth part sulphuric acid, and the solution allowed to cool.

3455. ELECTRIC LIGHTING. *W. E. Hubble, London.—9th August*, 1881.—*(A communication from A. F. W. Partz, Philadelphia, U.S.)—(Not proceeded with.)* 2*d*.

The invention is designed to light large spaces by large arc lights and reflectors.

3456. IMPROVED ELECTRICAL APPARATUS FOR LIGHTING AND OTHER PURPOSES, *W. R. Lake, London.—9th August*, 1881.—*(A communication from A. L. Arey, Cleveland, Ohio, U.S.)—(Not proceeded with.)* 2*d*.

This relates to devices for reducing the resistance of the generating machine, and for regulating the carbons of arc lamps so as to avoid flickering and unsteadiness of the light.

3463. CHAIN FOR PROTECTING SUBMARINE TELEGRAPHS, &c., *F. R. Lucas, London.—10th August*, 1881. 6*d*.

This consists in placing the cable through the links of a double chain, which form a sort of cage, so as to thoroughly protect the cable from dragging and chafing on the bottom of the ocean.

3538. REGISTERING BY ELECTRICITY THE NUMBER OF PICKS WOVEN PER INCH IN LOOMS, *G. J. Porritt, near Huddersfield.—11th August*, 1881. 6*d*.

The inventor attaches to the inside of the breast beam of the loom an apparatus actuated at each beat up of the slay or other going part, so that the result is indicated at a distance.

3539. ELECTRICAL APPARATUS, *W. R. Lake, London.—(A communication from C. Williams, jun., F. W. Harrington, and T. W. Lane, Mass., U.S.).—15th August*, 1881. 8*d*.

This invention relates to apparatus, switch boards, &c., for putting into or cutting out the generator from the circuit. One part of the invention describes apparatus for automatically putting the generator in circuit as well as causing the armature of the magneto-generator to rotate.

3665. IMPROVEMENTS IN THE DIVISION AND REGULATION OF ELECTRIC CURRENTS, *R. E. Dunstan, Donhead St. Mary, Wilts; and G. Pfannkuche, Westminster.—22nd August*, 1881. 6*d*.

This invention consists in the application of the solenoid principle to the division and regulation of electric currents, the suction exercised in the solenoid cores being made to throw resistances in or out of circuit as required.

3696. IMPROVEMENTS IN ELECTRO-MAGNETIC CLOCKS AND BATTERIES FOR THE SAME AND OTHER PURPOSES, *C. Shepherd, South Hampstead.—24th August*, 1881. 6*d*.

The inventor drives the clockwork by the reciprocating motion of the poles of a permanent magnet and electro-magnetic coils, or of electro-magnetic coils near the poles of a fixed permanent magnet, also communicating thereby continuous rotary motion to a fly-wheel or weights, so that the same shall revolve in equilibrium, the magnet or coils being suspended by a cord, spring, or knife edge. The improvements in batteries consist in the use in combination with a zinc element and a liquid element of porous material, such as burnt cinders, so arranged as to raise the liquid element by capillary attraction, and expose it to extended contact with air to prevent polarisation.

3808. IMPROVEMENTS IN THE MEANS AND APPARATUS FOR CONVEYING SOUND TO A DISTANCE FROM THEATRES, &c., BY TELEPHONIC TRANSMISSION, *C. D. Abel, London.—(A communication from C. Ader, Paris).—1st September*, 1881. 6*d*.

The inventor uses two sets of transmitters, one on each side of the stage, one of the receivers being connected with a transmitter on the one side, and the other with a transmitter on the other side. In this way the listener can detect by the variations in the sounds transmitted to either ear on which side of the stage the speaker is. To avoid the shocks occasioned by walking on the stage, the transmitters are placed in boxes, the bottoms of which are filled with lead, and which rest in caoutchouc blocks. As batteries will not last during a long performance without polarisation, the inventor employs a distributing apparatus by means of which a fresh battery for each transmitter can be switched on after a stated time, interrupters being placed in circuit to prevent any noise in the receivers being occasioned by the change of batteries.

3832. IMPROVEMENTS IN MACHINERY FOR WINDING OR COILING WIRE UPON ANNULAR ARMATURES FOR ELECTRO-MAGNETIC OR MAGNETO-ELECTRIC MACHINES, *W. R. Lake, London.—2nd September*, 1881.—*(A communication from A. Haase and J. P. Recker, Indianopolis, Ind., U.S.)—(Not proceeded with.)* 6*d*.

This invention relates to machinery for rapidly and compactly winding wire upon armatures. The machine has a clamp adapted to be secured to and surround the rim of the armature, a rim adapted to surround and revolve upon the clamp arms, one of which carries a spool containing the wire, and the other a counterbalancing weight, and fastening, guiding, and driving mechanism, as explained in the specification.

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4127. FIRE-ALARM WIRE OR COMMUNICATOR, *R. J. B. Mills, London.—24th September*, 1881.—*(A communication from P. A. Charpentier, Paris.)* 2d.

The conductor through which an electric current is to cause an alarm to sound in case of fire consists of two copper wires, the ends of which will be connected by means of a metallic soldering effected by the rise of temperature.

4165. IMPROVEMENTS IN TELEPHONE EXCHANGE APPARATUS AND SYSTEMS, *E. de Pass, London.—27th September*, 1881.—*(A communication from F. Shaw, New York, and W. A. Childs, Englewood, New Jersey, U.S.)—(Not proceeded with.)* 4d.

This relates to improvements in switchboards whereby space and expense as well as time are saved, and consists in reducing their size so as to put them under the control of fewer operations than at present.

4193. IMPROVEMENTS IN ELECTRIC LAMPS, *C. H. Gimingham, Newcastle-on-Tyne.—29th September*, 1881. 4d.

This relates to a mode of fixing the carbons of incandescent lamps. The inventor flattens out the ends of the platinum or metal connecting the carbon with the conductors, then forms the flattened ends into tubes by drawing through a wire plate, and inserts the ends of the carbon in such tubes.

4202. IMPROVEMENTS IN AND RELATING TO INCANDESCENT ELECTRIC LAMPS, *J. W. Swan, Newcastle-on-Tyne.—29th September*, 1881. 4d.

This relates to the welding together of the platinum sockets and carbon filaments by means of a deposit of hard carbon. Having shaped the sockets so as to receive the carbon filament, the inventor attaches them to a short stem of glass rod by fusion. He then inserts the carbon filaments into the sockets. The carbons, except in the immediate neighbourhood of the sockets, are copper electro-plated; they are then washed and dried, and immersed in a bath of some suitable liquor which will deposit carbon by the action of heat, and while thus immersed an electric current is sent through them, so that the sockets and parts not electro-plated are thickly coated with carbon, and the socket and carbon thoroughly welded together. To deposit the carbon exactly where wanted the inventor immerses the carbons in a bath of mercury nearly up to the point where it is required to deposit the carbon.

4207. IMPROVEMENTS IN DYNAMO-ELECTRIC MACHINES, *C. A. Barlow, Lancaster.—29th September*, 1881.—*(A communication from A. de Meritens, Paris.)* 6d.

This relates to a continuous current magneto-electric machine. It is composed of two magnetiser clusters of horseshoe form, each cluster having two arms, formed of sixty-four plates, which are arranged in a curve, so that their inner surface is equidistant from the periphery of the armature. The magnet carrier is of bronze, and the arms of the magnet pass through openings in it. The second magnet carrier is of cast iron, and forms the base plate or magnetic yoke, common to all the clusters. Outside the bronze carrier, on the driving shaft, is a ring containing sixteen bobbins of soft sheet iron, each of which contains four separate small bobbins wound with wire. The collector is composed of sixty-four plates of copper. The indicators of the machine are made of two clusters of permanent horseshoe magnets, the four poles of which form an almost complete circle. The brushes are carried in an adjustable frame. The inventor claims the base plate or magnetic yoke, improved collector and bobbins, and frame for carrying brushes.

4227. IMPROVEMENTS IN AND RELATING TO INSULATORS FOR ANIMAL MAGNETISM, *J. Lyon, St. Helens, Lancashire.—30th September*, 1881. 4d.

This consists in making the body of the insulator of glass, preferably rectangular, with rounded edges, one or more sides being hollowed out the more easily to retain the foot of the article supported. In the hollowed side a hole, or holes, are cut and filled in with a resinous non-conductor, as a mixture of resin and shellac. The inventor claims the combination in one insulator of a reservoir and vitreous non-conductor.

4271. IMPROVEMENTS IN ELECTRC-MAGNETIC APPARATUS, *W. R. Lake, London.—1st October*, 1881.—*(A communication from A. D. Maikoff and N. de Kabath, Paris.)* 6d.

The inventor constructs his electro-magnets so that the core surrounded by the wire coil acts not as heretofore upon an exterior armature, but upon one placed within the coil.

4294. IMPROVEMENTS IN THE MANUFACTURE OF INCANDESCENT ELECTRIC LAMPS, *A. G. Schaeffer, Newcastle-on-Tyne.—4th October*, 1881.—*(Not proceeded with.)* 2d.

This consists in introducing a platinum pipe into the glass globe through which the globe is exhausted, and which is closed up after exhaustion. It is also used as a support for the carbon and one of the conductors.

4296. CONDUITS FOR TELEGRAPHIC CONDUCTORS LAID IN STREETS OR ROADWAYS, *C. D. Abel, London.—4th October*, 1881.—*(A communication from L. A. Brasseur and O. Dejaer, Brussels.)—(Not proceeded with.)* 2d.

The conduit is made of trough shape, open at top along its entire length, and is provided with a flanged cover fitting over it, the cover being either separate or hinged to the trough on one side.

4304. IMPROVEMENTS IN DYNAMO-MACHINES FOR THE PRODUCTION AND DISTRIBUTION OF ELECTRIC CURRENTS, *H. Aylesbury, Bristol.—4th October*, 1881. 6d.

The inventor fixes in the main axle of his machine a large pulley having two V-grooves in its circumference, and on the interior of the surrounding cylindrical case he mounts a number of smaller friction pulleys, gearing with the grooves in the large pulley. On each side of each friction pulley he arranges a number, say from 2 to 12, of electro-magnets, and these revolve against permanent magnets mounted all round the circular case. Each pulley has an adjustable screw, so that it can be thrown in or out of gearing, as required. The inventor thus claims to be able to regulate the production of the current at will.

4305. IMPROVEMENTS IN ELECTRIC LAMPS, *H. J. Haddan, Kensington.—4th October*, 1881.—*(A communication from L. Somzee, Brussels.)—(Not proceeded with.)* 2d.

This relates to the production of light by means of a thin carbon rod and a rod of refractory material, the light being produced by the incandescence of the carbon combined with the voltaic arc formed at the circumference of the rod of refractory material.

4383. IMPROVEMENTS IN THE MANUFACTURE OF ELECTRIC BRIDGES FOR INCANDESCENT LAMPS, AND IN THE MEANS EMPLOYED THEREIN, *St. G. Lane-Fox, Westminster.—8th October*, 1881. 6d.

This relates to the inventor's process for manufacturing electric bridges for incandescent lamps by immersing baked threads or fibres in coal gas, and sending a current through them, raising them to a white heat, thus causing the carbon from the gas to be deposited on their surface, and thereby reducing them to a definite or specified resistance. It is an improvement on Patent 3494, dated 28th August, 1880, taken out for the above process, and consists in a description of the method of carrying out the above process on a manufacturing scale.

4396. IMPROVEMENTS IN THE MANUFACTURE OF CARBONS FOR ELECTRIC LAMPS AND APPARATUS FOR THAT PURPOSE, *J. James, Lambeth, and J. C. F. Lee, Beckenham.—10th October*, 1881.—*(Not proceeded with).* 2d.

This consists in the reduction of the carbonaceous material to a fine powder, which is subsequently subjected to great pressure in a mould.

4398. SECONDARY BATTERIES OR ELECTRICAL ACCUMULATORS, *A. W. L. Reddie.—10th October*, 1881.—*(A communication from E. Volckmar.)—(Not proceeded with.)* 2d.

The perforations to lead plates are filled with granules or filaments of lead, and then submitted to pressure.

4409. IMPROVEMENTS IN THE MANUFACTURE OF TELEGRAPH CONDUCTORS AND MATERIALS FOR COVERING AND INSULATING WIRE OR OTHER CONDUCTORS USED FOR TELEGRAPHIC OR OTHER PURPOSES, *W. O. Callender, London, 11th October*, 1881. 4d.

This invention consists in the use of bitumen combined with other hydrocarbons such as vegetable oil, so as to produce a compound material consisting of 80 to 40 parts bitumen to 20 to 60 parts hydrocarbons. The mixture when reduced to a liquid state is vulcanised by the addition of flowers of sulphur.

4455. IMPROVEMENTS IN THE CONSTRUCTION OF SECONDARY BATTERIES OR APPARATUS FOR EFFECTING ELECTRICAL STORAGE, *J. W. Swan, Newcastle-on-Tyne.—13th October*, 1881. 4d.

This is an improvement on the Planté battery, and consists in scraping, abraiding, or making incisions in the lead plates, so as to expose a larger surface to the action of electrolytic gases, and thus render the lead plates capable of rapid transformation into the condition necessary for storage. The inventor also presses the lead plates—which are to be used as pole plates of a battery—between other similar plates which have been incised or roughened, so as to communicate to the plates pressed between them their incised character.

4496. IMPROVEMENTS IN REGULATORS FOR ELECTRIC MOTORS, *J. H. Johnson, London.—15th October*, 1881.—*(A communication from La Societé Anonyme La Force et La Lumière, Brussels.) (Not proceeded with.)* 4d.

This relates to a means for controlling electric motors by means of a chain, the resistance of which varies as it is loose or tight, and firm pressure or weak pressure is inserted on its links.

4507. IMPROVEMENTS IN INSULATORS FOR TELEGRAPH AND OTHER WIRES, *A. E. Gilbert, Clapham, 15th October*, 1881.—*(Not proceeded with.)* 2d.

This invention relates to improvements in the ordinary porcelain telegraph insulators, by which friction at the point of suspension is reduced, and improved facilities for attaching and detaching the wires are afforded.

4508. PRODUCTION, COLLECTION, OR STORAGE AND DISTRIBUTION OF ELECTRICITY, *J. H. Johnson.—15th October*, 1881.—*(A communication from E. U. Parrod, Paris.)—(Not proceeded with.)* 4d.

This refers to automatic apparatus to place the batteries in connection with the generating apparatus.

4518. IMPROVEMENTS IN AND RELATING TO APPARATUS FOR DRIVING OR OPERATING SEWING MACHINES BY ELECTRICITY, *H. H. Lake, London.—17th October*, 1881.—*(A communication from J. J. Journaux, Paris.)—(Not proceeded with.)* 2d.

This relates to a means whereby a sewing machine may be operated by a foot treadle or an electric motor. The motor is movable, so that its driving wheel can be made to make frictional contact with the driving wheel of the sewing machine.

4533. IMPROVEMENTS IN ELECTRIC LAMPS, *P. R. Gibbs, Liverpool, 18th Octoder*, 1881. 6d.

This relates to the automatic lighting of the candles of Jablochkoff and similar lamps. The inventor places each candle between a socket secured to an insulated support, and a socket attached to a lever free to move on a fulcrum at its centre. The other end of the lever consists of a spring, the lever is of metal. The carbons forming the candle are held in position by springs. One conducting wire is secured to one of the fixed sockets and the other is in communication with a movable socket of one of the adjacent candles When a candle is nearly consumed the ends are shorter than an insulated strip placed in the candle; the movable socket thereupon being acted on by its spring moves into contact with the fixed socket and the current passes on through the next candle.

4582. IMPROVEMENTS IN THE ARRANGEMENT AND COMBINATION OF APPARATUS FOR GENERATING AND STORING ELECTRICITY IN RAILWAY AND OTHER CARRIAGES AND STEAMBOATS FOR THE PRODUCTION OF LIGHT THEREIN, *A. M. Clark, London.—19th October*, 1881.—*(A communication from Madame J. de Changy, née de Deyn, Paris.)—(Not proceeded with.)* 2d.

This invention consists in the combination of a dynamo driven by the axle of the carriage with a secondary battery, so that the battery may be charged during the revolution of the axle, and give current for electric lamps when said axle is at a standstill.

4591. IMPROVEMENTS IN THE MODE OF GENERATING ELECTRICITY, *H. J. Haddan, Kensington.—20th October*, 1881.—*(A communication from G. Dessaigne, Villefranche, France.)—(Not proceeded with.)* 2d.

This consists in adjusting magnets on the fly-wheels of ordinary engines, and placing electro-magnets round them, so as to generate currents when the fly-wheels are revolving.

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THE SCHOOL OF TELEGRAPHY & ELECTRICAL ENGINEERING.

ESTABLISHED IN 1868.

12, PRINCES STREET, CORNER OF HANOVER SQUARE, LONDON, W.

(Removed from 4, George Street, Hanover Square.)

MANAGING DIRECTOR: Mr. T. J. JONES, M.S.T.E.

The course of Practical and Theoretical Instruction in the higher branches of Overland and Submarine Telegraphy embraces, in addition to the manipulation of he various systems of working in general use, the following subjects:—

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The complete Practical and Theoretical course extends over a period of Six Months.

Arrangements have been made so that Inventors, Amateurs, and others can now have every facility, with all necessary apparatus provided in private rooms, to compare, test, or perfect any Inventions, Apparatus, &c., connected with Telegraphy, Telephony, and the Electric Light. Financial and the highest professional assistance can also be had.

Further particulars may be obtained on application to W. N. TIDDY, *Secretary.*

THE EXCHANGE TELEGRAPH COMPANY, LIMITED.

Head Offices—17 & 18, Cornhill, E.C.; Stock Exchange, E.C.; 27, Regent Street, W.

Incorporated the 28th March, 1872, under the Companies Acts of 1862 and 1867, and by Special License from H.M. Postmaster-General.

This Company will undertake to supply recording instruments, telegraphically connected with the Stock Exchange, by the aid of which Subscribers, at their respective offices, may be kept continuously advised throughout the day of the constantly occurring market fluctuations in stocks and shares.

Instruments are placed in the offices of Subscribers and kept in order by the Company, free of every expense but that of rent, and inspectors visit them daily to supply ink and paper.

Terms: £50 per annum, payable quarterly in advance.

Applications for instruments to be made to the Secretary at the above address.

Not having any springs or clockwork to wind up or to depend on, these instruments are acknowledged by those familiar with the system of telegraphy to be the only instruments yet invented that are capable of doing the work required of them continuously for a lengthened period, as evidenced by the fact that the Gold and Stock Company of New York, having the monopoly of this kind of business in the States, and which owns all the patents of the day of any value, has, after due trial, discarded all others.

The Company is prepared to treat with provincial Companies requiring instruments for the delivery of news for either single or double wire systems under the Company's patents, whereby from central stations identical information can be simultaneously delivered to any number of recipients by automatic, self-adjusting, printing instruments requiring no local batteries, no winding up, and no knowledge of telegraphy on the part of the receiver, the printing being in bold roman type, and the propulsion of the paper being effected by the electricity supplied from the Central Office.

The instruments supplied by the Company can be had to work either on single or double wires, and to print either on a slip or tape of paper, as has hitherto been the custom, or on a broad band of paper in column form.

The system has been in use by the Exchange Telegraph Company (Limited) in the City and West End of London since 1872, and by MacMahon's Telegraphic News Company (Limited), for the delivery of Parliamentary, Sporting, and General Intelligence, since 1879.

The Company will supply householders and others with its

DISTRICT CALL SYSTEM.

By the aid of a small automatic telegraph instrument a Subscriber can at any hour, day or night, call a messenger, cab, or policeman, or give the alarm of fire, and will obtain the required assistance within three minutes of making the signal. Subscribers, when absent from their homes for a season, can leave their houses closed, and have them taken charge of by the Company, and rendered perfectly secure against burglars by a telegraphic communication with the nearest District Call Station of the Company, where a policeman will always be in readiness day and night to respond to calls.

Provincial combinations to work under the Company's Patents will be treated liberally.

The Company is also prepared to supply Municipalities with its system of

STREET FIRE ALARMS

as recommended by H. M. Postal Telegraph Department to the Metropolitan Board of Works for the Metropolitan Fire Brigade, and which has received favourable mention by Captain Shaw in his last annual report.

These Alarms have recently been considerably improved by the Company, and are acknowledged to be the simplest yet constructed.

All communications to be addressed to the Secretary as above.

TO ELECTRIC OR OTHER LIGHTING COMPANIES.

BOROUGH OF KIDDERMINSTER.

The Improvement and General Purposes Committee of the Town Council are prepared to receive TENDERS for the LIGHTING of the BOROUGH for one year. Tenders may also be sent in for lighting the principal streets only.

Full particulars, together with a Plan of the Borough, may be obtained at my Offices on application. Tenders to be delivered to me, not later than 10 a.m., on AUGUST the 9th, endorsed "Tender for Lighting."

The Committee do not pledge themselves to accept the lowest or any Tender.

ARTHUR COMBER, Borough Engineer.

Town Hall, Kidderminster,
July 25th, 1882.

Now Ready, 12mo., 7s. 6d., cloth, postage 3d.,

THE ACTION of LIGHTNING, and the Means of Defending Life and Property from its Effects (suggesting some new and economical methods of defence). By Major ARTHUR PARNELL, Royal Engineers.

"Major Parnell has written an original work on a scientific subject of unusual interest; and he has prefaced his arguments by a patient and almost exhaustive citation of the best writers on the subject in the English language."—Athenæum.

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A FOREMAN WANTED.—Must be able to work Gas Engines and Dynamos, and must have had experience in Electric Installations and General Mechanical Work. Apply, stating wages, to the SECRETARY, Duplex Electric Company, 9, Soho-square, W.

A SHOP MANAGER WANTED.—Must thoroughly understand the trade in Electric and Philosophical Instruments and Fittings. Apply, stating experience and remuneration expected, to SECRETARY, Duplex Electric Company, 9, Soho-square, W.

ASSISTANT ELECTRICAL ENGINEER WANTED in London, to devote his whole time to the work. Salary to commence at £300 per annum. Apply by letter, enclosing testimonials, &c., to Professors AYRTON and PERRY, St. Stephen's-chambers, Telegraph-street, E.C.

A FULLY QUALIFIED MECHANICAL ENGINEER, with some experience of Electrical work, desires an ENGAGEMENT with an Electric Lighting Company. Address "A.M.Z.," 396, Strand, W.

PATENT OFFICE RESEARCHES.—An OXFORD GRADUATE, experienced in ELECTRICAL SUBJECTS and in the Investigation of Scientific Books and Documents, undertakes CONFIDENTIAL RESEARCHES for INVENTORS and others.

Address "X.B.," Office of ELECTRICIAN, 396, Strand.

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SLIP

Telegraphic Extension in Canada.—It is stated that telegraphic communication between Winnipeg and Minnesota is now complete.

West Indies.—The cable between Trinidad and Grenada is now repaired, thus restoring telegraphic communication with all places in the West Indies.

Electric Light for Colwyn Bay.—It is stated that arrangements are being made to light Colwyn Bay, in North Wales, by means of the Brush system.

West Indies.—The report of the delegates to the Telegraphic Conference recently held at Barbadoes is to be referred for consideration to the Combined Court.—*Colonies and India.*

House of Commons Telegraph Office.—During the six months ending 30th June last no less than 25,000 telegrams passed through the telegraph office in the House of Commons.

West Coast of America Telegraph Company.—The gross earnings of this company's traffics and steamer for the first half of July amounted to £1,825, against £1,675 in the corresponding period last year.

Eastern Extension Telegraph Company.—The traffic receipts of this company for the month of July, 1882, amounted to £30,070 and to £31,751 for the corresponding period of 1881, being a decrease of £1,681.

Electric Lighting Bill.—This Bill was read a third time in the House of Commons on Friday (28th July) and passed. On the same day it was also read a first time in the House of Lords, the second reading being fixed for Thursday.

Electric Light in London.—The Metropolitan (Brush) Electric Light and Power Company (Limited) have secured contracts to light up the Royal Mint, the premises of Messrs. Halling, Pearce, and Stone, and the Floral Hall, Covent Garden.

New Cable between Alexandria and Port Said.—The Government are negotiating with the Eastern Telegraph Company with respect to the laying of a cable, should it be found necessary, between Alexandria and Port Said, and through the Canal to Suez.

West India and Panama Telegraph Company.—The estimated traffic receipts of this company for the half month ended July 31 are £2,400, as compared with £2,017 in the corresponding period of 1881. The April receipts, estimated at £6,958, realised £6,990.

A New Secondary Battery.—We understand that an effort will be made to exhibit a FitzGerald-Crompton accumulator at the forthcoming meeting of the Mechanical Engineers at Leeds. This accumulator is said to be theoretically better than any yet before the public.

The Telephone in America.—It is stated that the Denver (Colorado) Telephone Exchange has 620 subscribers, and that the number is constantly being added to. A new line has also been constructed through the mountains from Denver to Golden, thence to Idako Spring, Central City, and Georgetown.

Standard Time in Natal.—We learn that an electric clock has been imported by the Natal Government, and is to be fitted upon the Maritzburg Telegraph Office. The clock will be connected with Cape Town, and will daily receive regulation from there until the time when Natal has an observatory of its own.

Electric Lights for the Navy.—H.M.S. "Thalia," which was recently fitted out at Portsmouth, has been fitted with a dynamo and two electric search lights. She is to proceed to Egypt for service in the Suez Canal. The lights are worked from her fore bridge, and the machinery is fixed on the after part of the troop deck, abaft the funnel casing.

SS. "Calabria."—This fine cable ship, belonging to the Telegraph Construction and Maintenance Company, has been selected by the Government to take out the second half of the Household Cavalry for service in Egypt. She is, owing to her excellent cabin accommodation, to have the distinction of taking out the general of the cavalry division and the commanding officer of the above regiment.

The Edison Lamp Factory.—This factory has been removed from Menlo Park to larger buildings at East Newark, New Jersey. The work of making lamps began in the new factory on 1st June last, 150 men being employed. The factory will be able to turn out 1,200 lamps per day for the present, but arrangements could, we believe, be made for increasing the number to 40,000 lamps per day, which would require some 3,000 or 4,000 hands.

Electric Lights for Camberwell.—At a recent meeting of the Camberwell Vestry it was stated that only one tender had been received in response to the invitation recently issued to tender for lighting Church-street, Camberwell-road, and High-street, Peckham, by means of electricity. The vestry determined, taking into consideration the cost of electric lighting as against the present cost of gas, to defer consideration of the matter for the present.

Edison v. Swan.—An application was made on July 28 to Mr. Justice Chitty by the Edison Electric Light Company (Limited) in an action brought by the company against the Swan United Electric Light Company (Limited) to restrain that company from supplying incandescent lamps, alleged to be infringements of Mr. Edison's patent rights, which have been purchased by the plaintiffs. The motion was directed to stand over until the hearing of the action, the defendants undertaking in the meantime to keep an account.

Electric Light in Paris.—M. G. Sandoz, a clockmaker of the Palais-Royal, Paris, has been lighting up his shop recently by means of twenty-four Swan lamps, fed by twenty-four Faure accumulators, supplied by La Société Force et Lumière, and weighing sixty kilogrammes each. These accumulators, according to M. Gustave Sandoz, will work the twenty-four lamps for eight consecutive hours. The temperature of the shop when lighted by gas is stated to be some 10 degrees higher than when it is lighted by the electric lamps.

Carbons for Electric Lamps.—According to M. Jacquelain the natural graphitoïd of Siberia acquires by purification double the luminous capacity it has in its natural state, which is greater than that of pure artificial carbons by one-sixth. M. Jacquelain gives three methods of purifying and hardening carbons by which he has obtained good results. They are as follow:—(1) By directing a jet of dry chlorine gas on to the carbon when raised to a light red heat, (2) by the action of potash and caustic soda in fusion, (3) by the action of hydrochloric acid on the carbons when finished.

Electric Light in the Severn Tunnel.—With reference to the note under this head published in our last issue, we have received a copy of a letter which has been addressed to the editor of the *Western Mail* by Mr. John Parsons, general manager of the Great Western Electric Light and

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Power Company, in which he says that the statement that this company had supplied lights and machines for the Severn Tunnel works was quite correct, the order, however, being received through Messrs. Gooch and Huni, which might account for Mr. Walker's statement that he had "never heard of" the above company.

ANOTHER APPLICATION OF ELECTRICITY.—The call for an electrical sheep-shearer, made by a New Zealand correspondent in these columns some months ago, says the *Scientific American*, has apparently brought forth fruit in an unexpected quarter. The head of the Hudson Bay Fur Company of England is Sir Curtis Lampson, by birth a Vermonter. It is now announced that he has applied electricity to the trimming of seal skins. The skin is "fed" over a knife-edge bar, above which is stretched a fine platinum wire, which, raised to a white heat by an electric current, meets the longer hairs which rise above the under fur, and mows them down.

INTERNATIONAL ELECTRIC AND GAS EXHIBITION.—The number of entries that have already been received indicate that this exhibition will be of a complete and interesting character. It is in contemplation to divide the palace for the purposes of the exhibition into two sections, one to be lighted by gas, the other by electricity. There will be certainly not less than a dozen distinct systems of electric lighting in the portion of the palace set aside for that purpose. It is expected that the whole of the recent improvements in gas lighting, and the various applications of gas to cooking, heating, &c., &c., will be shown. The date for receiving applications has been extended to the 14th inst., subject to there being space for applicants.

THUNDERSTORM AT HULL.—A provincial contemporary is responsible for the following:—A thunderstorm of a terrifying nature passed over Hull shortly before two p.m. on Tuesday week. The flashes of lightning were very vivid, and the peals of thunder terrific. A most singular phenomenon was experienced on the Monument Bridge. The iron girders of the bridge appeared to attract the electric fluid, and several persons who were passing over at the time felt the flashes playing about their persons, and experienced a choking sensation. At the Town Hall the lightning had some effect on the telephone which is connected with the Parliament-street Police Station and Stoneferry Waterworks. The electric bells were set ringing, and did not cease for several hours afterwards.

TELEGRAPH CLERKS' LEAVE.—On Thursday week Mr. Fawcett replied as follows to a question put by Mr. J. M'Carthy in the House of Commons on that day, referring to annual leave:—"I have to state that in the case of telegraphists the rules with regard to annual leave are uniform throughout Ireland. A telegraphist at Dublin, therefore, should have no longer leave than one at Belfast discharging the same duties and to the same extent, and I am not aware that any difference is made. As stated in reply to a former question put by the hon. member on the same subject, the exceptional privileges which some of the Belfast telegraphists now enjoy in the matter of leave will not be extended to new intrants, by which term is meant all persons joining the Belfast Post Office since 1879, whether they have come from other offices or not."

THE TELEPHONE IN BRAZIL.—The Telephone Company of Brazil completed its first year's work on May 23rd. Its central exchange in Rio de Janeiro, which opened with fourteen subscribers, at the close of the year, on the 23rd of May, had some 200 exchange and 50 private line subscribers, 300 miles of wire run, occupied over 500 roofs, and had in use 170 Siemens's iron poles. Upwards of 1,000 calls per day are made over the exchange wires. Mr. F. W. Jones, who held the position of general superintendent of the company during the first year, left for Buenos Ayres on May 20, to look after telephone affairs there. Mr. C. P. Mackie, formerly vice-president of the company, has been elected president, and Mr. William I. Donshea, the former electrician, has been chosen for superintendent. The company gives daily coffee quotations to its subscribers.—*Operator*.

A THUNDERSTORM IN THE MATTERHORN.—The following description of a thunderstorm which took place on the Matterhorn appeared in a letter in a recent issue of *The Times*, written by Mr. A. S. M. Buttemer, and dated Lausanne, July 26. The letter says:—"The morning had been fine and warm, but about noon snow fell. On the top the sun came out, and the view on the Italian side was perfectly clear. About five minutes after commencing the descent the sky suddenly became dark, and snow fell in such density that, as one of our party described it, you could grasp a handful from the atmosphere. A peal of thunder made our guides hurry on. Directly afterwards we heard a sharp crack, resembling the report of a rifle, and each of us felt a slight shock in the head. A peal of thunder followed instantly. The guide, who was carrying an ice axe, threw it away in alarm. A second and much louder crack followed in about a minute, and we all experienced a powerful shock. The guides felt it in the head, and one of them complained of a severe headache for the rest of the day. My wife described it as passing through the body. I felt it entirely in the knees, which seemed as if momentarily dislocated. Thunder followed immediately as before. After this there were a few distant peals of thunder, and in an hour the snow ceased and the sun came out."

ELECTRICITY AND FLAME.—A valuable contribution to the subject of the electricity of flame has been lately made by Herren Elster and Geitel (*Wied. Ann.*, No. 6). The discrepancies in previous results are attributed largely to the behaviour of the air layer immediately outside of the flame having been left out of account. The authors used a Thomson quadrant electrometer for measurement. They find the supposed longitudinal polarisation of flame merely apparent, and due to unequal insertion of the wires used as electrodes. On the other hand, flame is strongly polarised in cross section; an electrode in the air about the flame is always positive to one in the flame. The theory the authors adopt is this:—By the process of combustion *per se* free electricity is not produced in the flame; but the flame-gases and the air-envelope have the property of exciting, like an electrolyte, metals or liquids in contact with them. To this electrolytic excitation is added a thermo-electric, due to the incandescent state of the electrodes. The amount and nature of the electric excitation is independent of the size of the flame, and dependent on the nature, surface-condition, and glow of the electrodes, and on the nature of the burning gases. *Inter alia*, it is remarked that flames may be combined in series like galvanic elements, and so as to form a "flame-battery."—*Nature*.

TELEGRAPH CLERKS' GRIEVANCES.—In the House of Commons on Thursday week Mr. Justin M'Carthy asked the Postmaster-General if it was true that telegraph clerks in provincial and other offices had, since the promulgation of the scheme purporting to improve their position, been called upon to work for 20, 30, and 40 minutes daily over their established hours of duty and without being paid for those periods at the specified rate per hour? If it was a fact that clerks who had such extra duty to perform would not be per-

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mitted to claim at the end of the week, and that, in such instances where they did claim for the total number of hours worked at that rate in the week, the claim was disallowed? And whether it was with his approval that that system is carried out, and if not, whether he would allow all fractions of an hour over time to be paid for at the ordinary rate per hour? Mr. Fawcett said in reply: "I have to point out that any system of payment for overtime needs to be very carefully watched in order to prevent its encouraging dilatoriness in work. It has been a long-established practice in the Department not to pay for overtime under one hour, and I think it would be undesirable to alter this practice so as to allow a fraction of an hour to be counted for overtime. I shall be glad if the hon. member will give me the instances in which overtime is daily required in the manner indicated in his question."

Electric Light in Santiago.—A correspondent informs us that a company to work Edison's system of incandescent electric lighting has been formed at Santiago, in Chili, South America, with a capital of £300,000. An exhibition of the Edison system has for some time past been open in Santiago, and proved so successful that this company has been formed to introduce the lights on a larger scale. It may be mentioned that this exhibition was under the charge of Mr. Stewart, an assistant of Mr. Edison's, to whom the credit of its success is due. In view of the extended use of the Edison light in this city, the new company are erecting a station with six dynamo machines, having a capacity of 250 lights (16 candle-power) each, and three machines of 60 lights capacity each, or enough to supply current to a total of about 1,680 lamps. The power will be supplied from three steam engines, and the connections, &c., will be very similar to those of the Edison Company's exhibit at the Crystal Palace. From this station there will radiate some 2,500ft. of conducting mains, which will carry the current to two galleries, several shops, and the grand "foyer" of the opera house, together with the street in which the station is situate. Our correspondent concludes as follows:—"A canvass of Santiago has just been completed, and sixty thousand lights have been subscribed for. Gas shares also have declined from 160 to 108 [presumably dollars, but our correspondent does not say so], and continue to fall rapidly." The station in Santiago will be modelled upon that already established in London by Mr. Johnson and Mr. Hammer, whose excellent work appears to have greatly assisted Mr. Stewart in Santiago.

An Electric Hammer.—M. Marcel Deprez has lately constructed an electric hammer, the description of which will call to the minds of our readers many lecture experiments to show how a hollow coil of wire, or solenoid, would sustain a heavy weight of soft iron in its centre so long as a current of electricity was passing through the coil, but would allow the weight to drop directly the current ceased. M. Deprez's hammer consists of a solenoid of about 1 metre long, composed of a series of flat coils superimposed on one another and forming a hollow cylinder, within which a second cylinder of soft iron, weighing about 25 kilogrammes, is free to move. The flat coils, to the number of about 80, are connected to one another, in such a way that the last turn of wire of the first is joined to the first turn of wire of the second, and so on. All these coil connections are connected with a circular commutator or collector. Two brushes or rubbing contacts work on the face of this collector at such an angle as to include between them ten contact plates of the collector. The brushes are moved by means of a double handle. The connections between the two brushes and an electric generator are so arranged that the current enters by one brush and leaves by the other, after having traversed ten of the coils which are in connection with the ten commutator plates included between the brushes. Thus, the current can be admitted into the higher or lower coils of the solenoid by turning the commutator handle, and the enclosed soft iron core, or hammer, raised or lowered accordingly. It is said that the blows to be given can be regulated with great nicety, and that with a current of 43 amperes, and five coils included between the brushes, the weight of the blow struck by the hammer was 70 kilogrammes, or three times its original weight.

Proposed Electric Exhibition at the Aquarium.—It is proposed to hold an exhibition of all classes of electrical apparatus at the Royal Aquarium, Westminster, from the 1st November next until the 1st of March following. "It has been determined in this exhibition," to quote from the proof of the prospectus with which we have been favoured, "to endeavour to concentrate attention upon such points as will be of practical value in extending the use of electricity, and facilitating its adoption by dealing with questions hitherto overlooked, or at all events imperfectly touched." To this end prizes of an aggregate value of £1,000 or over will be given, which will be awarded by a committee to be nominated by the scientific societies. The prizes will be given for some 18 subjects, grouped roughly as follows:—1. System of storage and generator for railway work. 2. Storage batteries. 3. Models for utilising various powers for storing energy. 4. Electro motors for stationary work. 5. Dynamos. 6. Model of central station for incandescent lighting. 7. Meters. 8. Fancy fittings for electroliers, &c. 9 to 11. Other kinds of fittings. 12. Street mains. 13. Electric train couplings. 14. Photometers. 15. Electro-dynamometers. 16. Thermopiles. 17. Lamps for mines and submarine work. 18. Medical appliances. We believe that the above items may be subjected to final revision; but, roughly speaking, these are the outlines of the subjects for competition. Applications for space are to be made before the 15th August, though foreigners will be allowed until the 1st September. The directors of the Aquarium will only supply the space to each exhibitor at a certain rent, and he must make all necessary connections to supply himself with gas, water, &c. Further information can be had of Mr. W. D. Gooch, A.S.T.E., 17, Royal Exchange, E.C., who is the engineer to the proposed exhibition.

Extraction of Nickel.—An American contemporary gives some account of the Thomson process for the extraction of nickel as described by Messrs. Eustis and Howe. It consists essentially in first rendering the nickel magnetic, and then separating it from the materials with which it is mechanically mixed by means of a magnetic separator. In the case of oxidised compounds of nickel, it would generally be desirable to bring the nickel to the metallic condition in which it is most highly magnetic. The compounds of nickel with sulphur would, probably, in the greater number of cases, be most readily separated by bringing the nickel approximately into the state of subsulphide, in which condition it is also magnetic. In most cases where nickel occurs with a considerable proportion of the heavy metals, it would be best to effect the magnetic separation before fusing the material, since, on fusion, the nickel would enter into a chemical combination with the other metals present, as an alloy, matte, speise, or similar compound, from which, of course, the magnet could not separate it. For cases where nickel occurs with a large proportion of iron, the following plan has been proposed by the writers: The either naturally or artificially oxi-

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dised compound of nickel is treated with a mixture of carbonic oxide and carbonic acid, or of other reducing and oxidising gases, in such proportions that they are capable of reducing nickel so nearly to the metallic state as to render it magnetic, but still containing so much carbonic acid or other oxidising gas as to be unable to reduce iron to that condition. It cannot be positively stated that it is possible in this way to render nickel magnetic without at the same time rendering iron magnetic, but experiments made by the writers render it probable that this can be effected. Having rendered the nickel magnetic, it can then be separated with the magnet from all matter with which it is mechanically mixed. This method of reducing nickel with a mixture of gases not sufficiently reducing to render iron magnetic is an application of a general method patented by the writers. Experiments tried with the nickle ores of Orford, Quebec, Canada, which contain a small portion of pure millerite, with calcite, pyroxene, and chrome garnet, gave a concentrate containing over 60 per cent. of nickel.

Electric Lighting at Brussels.—In a recent report on the electric lighting of the telegraph office at the Northern Station, Brussels, M. Dumont, engineer to the Belgian Telegraph Department, gives some particulars as to the results obtained. The office is lighted by means of three Jaspar regulators, connected to three Gramme machines, workshop type, by cables about 65 metres long, formed of seven copper wires covered with gutta percha. An Otto gas engine, driving two Gramme machines, developed a power of 5 horse-power, or $2\frac{1}{2}$ horse-power for each Gramme machine. Photometrical measurements, made with a Bunsen photometer, gave for each regulator 835 candles of light, burning 10·8 gm. of stearine per hour, with a flame 8 cent. high, the electric arc and the flame of the candle being placed in the same horizontal line. With the gas engine making 160 revolutions and the Gramme machines 930, the intensity of the currents measured on a Siemens electro dynamometer, varied from 15 to 16·6 amperes. The difference of potential, measured by the condenser discharge method, was found to be 51 volts at the terminals of the lamps and 57 volts at the terminals of the Gramme machines. Applying Joule's formula to these facts we have as the electrical work in the lamps $\frac{15·8 \times 51}{9·81 \times 75}$=1,095 horse-power, or about 44 per cent. of the $2\frac{1}{2}$ horse-power of work furnished by the Otto motor. The lighting of the office by gas is effected by 70 burners consuming 140 litres, or altogether 9·800 cubic metres per hour, which is paid for at the rate of 0·15fr. per cubic metre. The expense is thus 1·47fr. per hour, plus 0·15fr. for broken chimneys, &c., or a total of 1·62fr. The Otto engine consumes 8 cubic metres per hour at the cost of 1·20fr. The expenses of the lighting for four hours are as follow: Carbons for three lamps, 2·24fr.; gas for the motor, 32 metres, 4·80fr.; half a litre of oil, cleaning rags, &c., 0·75fr.; salary of the attendant in charge of the lamps, 4fr., giving a total of 11·79fr., or 2·95fr. per hour. Adding 10 per cent. to the cost of installation, which was 3,500fr. for 70 gas burners, and 12,765fr. for the electric lights, we have the actual cost of the lighting per hour as 1·86fr. for gas, and 3·82fr. for electricity. Taking count of the difference in the luminous intensity, M. Dumont finds that the price of the gas candle per hour was 0·0035fr., that of the electric candle, 0·00076fr., or 4·6 times less. The success of the electric lights in the telegraph office has led to their adoption for the square leading to the station.

The Proposed New Cable Company.—With reference to the letters in *The Times* which were given in a note in our last issue, Mr. S. L. Tomkins, secretary *pro tem.* of the proposed new company, writes to correct an error in his letter referring to the amount set aside by the Anglo-American Cable Company for repairs. What he meant to say was that this company had set aside £75,000, less £11,000 for repairs, in the last six months, and that "if they considered £64,000 sufficient for half a year for four old cables with their capital of £7,000,000, surely £45,000 a year for two new cables with our capital of £1,500,000 is ample." A rejoinder to Mr. Tomkins's letter also appeared in *The Times* of July 31st from Mr. H. Weaver, managing director of the Anglo-American Cable Company, the substance of which was as follows:—"1. The system of cables possessed by the associated Atlantic companies is as follows:—The Anglo-American Company's consists of the 1869, 1873, 1874, and the 1880 cables, 4; the Direct United States Cable Company, 1; La Compagnie Française du Télégraphe de Paris à New York, 1; and the American Telegraph and Cable Company, 2—total 8 cables, as stated in my previous letter. It is quite true that the Anglo-American Company have abandoned three cables, viz., the 1858, 1865, and the 1866, which have been replaced by the 1873, 1874, and 1880. 2. The amount of capital expended upon the above-mentioned system has really nothing to do with the question at issue, however large that sum may be. The cables which represent it exist, and have to be reckoned with by new competitive enterprises in the division of traffic. 3. According to Mr. Jarvis's statement, my estimate of 'paids out' does not appear to be largely in excess of what is actually required; but, assuming it to be 'included in the estimate for working expenses,' this fact only diminishes the loss of £31,000 a-year, and does not materially alter the result of my calculations. 4. Telegraphic science has, no doubt, made considerable progress since the Anglo-American cables were laid, but the Anglo-American Company has one very important advantage over all possible competitors, from the fact that they have the exclusive possession of the shortest route across the Atlantic by at least 600 miles, *viâ* Newfoundland; and I venture to assert that no electrical engineer who is acquainted with the length and type of those cables will state that the carrying capacity of the proposed new cables will either be superior or even equal to them. The idea that the traffic will spread itself over the twenty-four hours is simply illusory, as the difference of time of five hours between London and New York renders such a theory impracticable. 5. My statistics of the results of the 6d. rate in 1880 are actual facts, and in my calculations I have allowed 3,000,000 words for the 'natural development of trade.' 6. I think I have shown that my calculations are not 'founded upon the fallacy of there being ten cables,' seeing that the existing companies already possess eight; and, assuming that the new company lays two, the total number would be ten. And in order that there may be no possible misapprehension on the part either of the proposed new competitive company or their intending subscribers, I cannot too strongly reiterate that the whole of the traffic, whether produced by 'low rates' or by 'the mutual system,' would not be monopolised by the new company 'to the extent of their capacity,' but, on the contrary, that the old companies would take at least eight-tenths of it; as the experience of the last 12 years conclusively proves that for the protection of their property they have been forced unwillingly, in the face of competition, to adopt unremunerative rates. I will conclude by stating that for many years past the Anglo-American Company have placed £150,000 a year to their renewal fund, and not £75,000 as stated by Mr. Tomkins."

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THE CRYSTAL PALACE EXHIBITION.

Post Office Exhibits.

(CONTINUED FROM PAGE 246.)

Before we deal with the pneumatic system of transmission largely used at St. Martin's-le-Grand for supplementing electrical transmission for local purposes, we shall describe an arrangement adopted at some smaller establishments for despatching messages through short pneumatic tubes.

Fig. 19 shows a pneumatic apparatus of this kind used for sending telegraph message-forms (or other small documents) from the counter of an office to the instrument room, as designed by E. G. Rivers, Esq., of H.M. Office of Works, and constructed by Messrs. Simpson and Company, engineers, Pimlico. It consists of an air compressor, A, operated by a crank, B, and hand-wheel, C. The air from the compressor passes from the valve-boxes D to the solid drawn brass tubes E. The carriers, which can hold twelve message-forms easily, are made of a light material, covered with felt, and are somewhat less in diameter than the tube, except at one end, which is furnished with a washer of thick felt. The carriers are inserted in the receiving piece F, which is closed by a revolving shutter, and are driven through the tube into the cage G. One of these machines at work at Newmarket has a delivery tube about 450ft. long, with several bends; yet over 2,000 *messages an hour* have been sent by it from the public office to the new instrument room. The carrier is about 10 seconds in transit. There are now about 30 of these machines at work in various post offices, &c. This pneumatic device was an attractive feature of the Post Office exhibit. About 130ft. of brass piping was raised nearly 10ft. from the floor, and visitors were enabled to watch the transit of a carrier through a glass tube four feet long, fixed midway between the ends of the path. Sightseers were occasionally shown the transmission of several carriers simultaneously. Despatches can only be forwarded one way by means of the hand system just described; but pneumatic communication on a large scale admits of transmission either way. At the General Post Office there are three compound air-compressing and exhausting engines, each of 50 horse-power (nominal), and a fourth is now being erected. Two of the three are working during the day, and one all night. There are twenty-six pneumatic tubes between the central office and seventeen of the more important offices in the City and West End. Some of these offices have two tubes, one "up" and the other "down." Several of the foreign cable companies are also connected with the central office by pneumatic tube. Messages passing from the central office to a branch office are sent by compressed air, and those

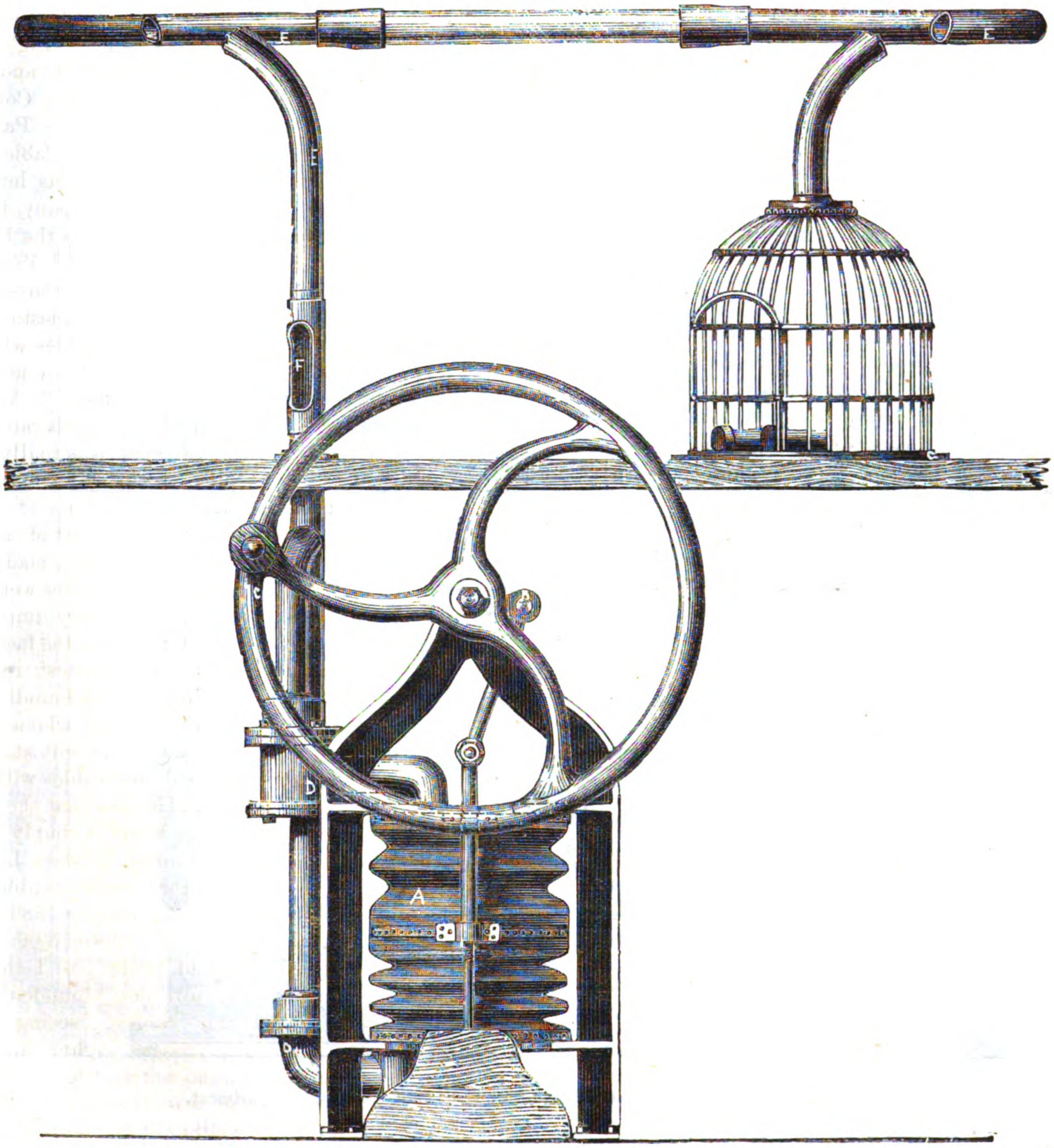

FIG. 19.—Pneumatic Transmitting Arrangement for Short Distances.

coming from a branch office to the central office by vacuum. The longest tubes are those working to the House of Commons, West Strand, and Lower Thames-street. The length of the former is about two and a-half miles, and carriers containing messages are blown through in from five to seven minutes. The latter are about two miles in length, and the times occupied in transit are from three and a-half to four and a-half minutes. The apparatus in connection with the twenty-six tubes occupies the whole of one end of the central instrument gallery. A set of such apparatus as exhibited at the Crystal Palace is represented in Fig. 20. Those tubes which are used exclusively for forwarding messages are situated at one end of the series, those which are used for both forwarding and receiving in the centre, and those for receiving only at the other end.

The valves are so arranged that they can be employed for (1) exclusively forwarding messages by compressed air; (2) exclusively receiving messages by exhausting air; and (3) for alternate forwarding and receiving on a single tube. We will call that portion of the pipe situated between E and G (Fig. 20), where a small window is represented, the *message chamber;* the top joint above, the *upper valve;* and the bottom of the pipe, the *lower valve.* At the joint in the centre the pipe is contracted to the diameter of the subterranean message pipe. Across the lower end of the pipe, below the message chamber, there is a horizontal handle forming one end of a rectangular brass slide, which is pulled outwards or pushed inwards when a carrier is to be forwarded or received. The slide actuates the valves. The withdrawal or insertion of the slide opens or closes the lower valve, and the same movement causes an oblique lever behind the piece of pipe we have described to open or close the upper valve in opposition to the lower. Near the slide handle on the right there is a small roller attached to the pressure valve. As represented, the pressure valve is closed; but when the slide is drawn forward an incline plane on its right arm presses against the roller and pushes the rod attached thereto inwards, thus opening the pressure valve and allowing compressed air to enter the message chamber. The stop-cock beneath belongs to the exhaust main, and connects the message chamber with the vacuum tank. The carriers are similar to those already described, but vary in size, some holding upwards of fifty message forms. At the foot of the drawing there is represented a piece of the lead message pipe, having a portion cut away for showing the carrier inside, with the buffer end exposed. The subterranean lead pipes are enclosed in iron pipes.

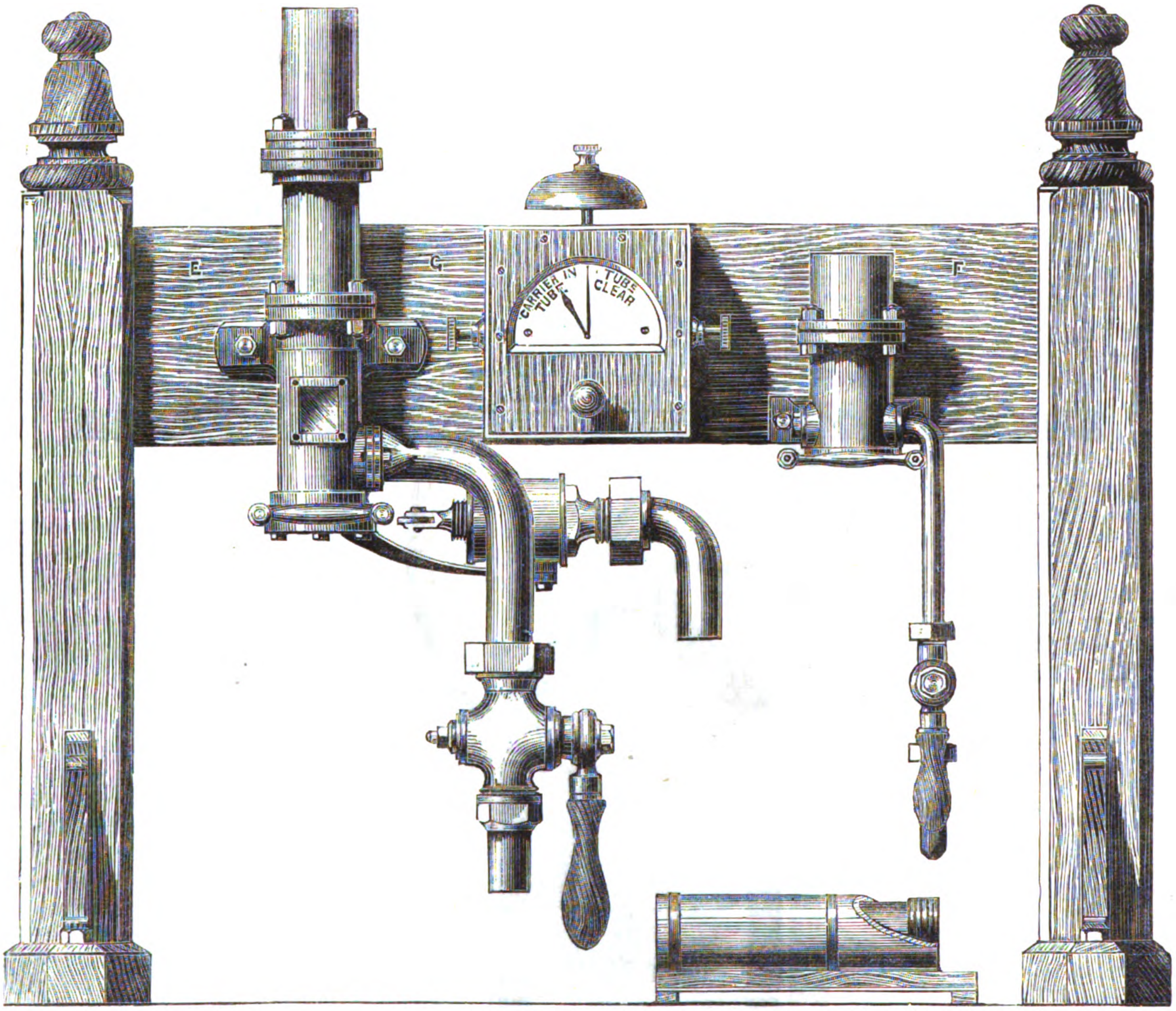

FIG. 20.—Pneumatic Apparatus adopted by the Postal Telegraph Department.

The combined electrical signal bell and indicator, shown in the middle of the cross arm of Fig. 20, is worked on the block system. The indicator shows "carrier in tube" on the left, and "tube clear" on the right. The button in front of the indicator is pressed inwards when a carrier is to be forwarded, causing the index needle on the home and distant instrument to indicate "carrier in tube," and also rings a bell to call attention. The attendant now withdraws the slide, which, firstly, closes the lower valve; secondly, opens the upper valve; and, thirdly, by opening the pressure valve, causes the compressed air to drive the carrier through the

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message pipe. On its arrival at the other end, the electric indicator is operated by the attendant there, and the needles register "tube clear."

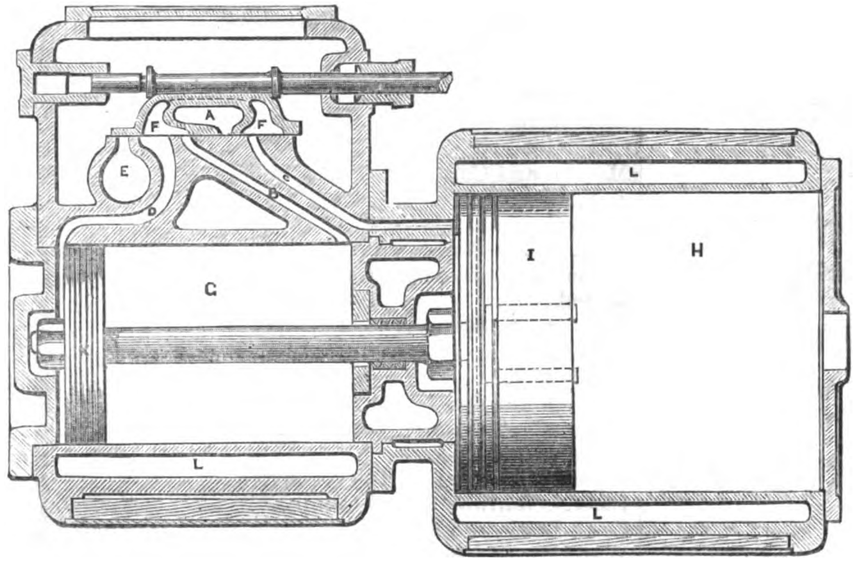
A receiving or inward tube is actuated as follows:—The distant attendant, on putting a carrier into the message chamber, rings the electric bell. The officer at the central station turns a stop-cock belonging to the pressure valve pipe (but not represented in the figure), so as to detach the compressed air main from the pressure valve. He then draws the slide forward, and next establishes communication between the message pipe and the vacuum reservoir by opening the exhaust stop-cock (visible in the drawing). When the carrier reaches the message chamber at the central office the vacuum main is cut off, the slide pushed back enabling the carrier to drop out, and the necessary electric signals given.

(TO BE CONTINUED.)

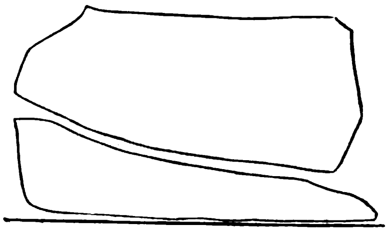
BURRELL'S COMPOUND PORTABLE ENGINE.

At the Royal Agricultural Society's Show, held at Reading three weeks since, various engines suitable for driving electric light machinery were shown. Some of these were identical with those we have already illustrated in our articles on the Crystal Palace Exhibition, others we shall hope to describe and illustrate in future issues.

The engine we wish to call attention to now is a compound portable engine by Messrs. Burrell and Sons, of Thetford, in which there are several new points, and from which the makers expect great things in the way of economy and steady driving. We say expect—we might say, have obtained, as we are informed that the engine has worked most satisfactorily at the trials that have been made with it.



Sectional View of Cylinders of Burrell's Engine.



Diagrams from Burrell's Engine.

We give above an illustration of the cylinders of this engine. A is the steam port in the slide valve, B is the live steam port leading into the high pressure cylinder G, which is the only side of the piston or cylinder end which receives live steam direct from the boiler. After the steam has gone a portion of the stroke is cut off and allowed to expand, and when the valve reaches the position as shown, the steam returns through the port B and communicates through port D at the opposite end of the cylinder G, at the back of piston K. This high pressure piston is then in equilibrium, the pressure acting on one side of the piston being equal to the pressure on the other. The reduced pressure also acts through the port F, in the valve communicating with the port C, on larger piston I, which gives return stroke. F is exhaust port, which takes place when the port F in the slide valve opens over the port E. Exhaust takes place from the back of the pistons I and K, through the ports at C and D. L L are the jackets. H is the low pressure cylinder.

The packing, which requires no attention for a very long time, is composed of copper wire gauze, worked into square rings, and, being porous, baffles the steam, so that it is perfectly tight, without requiring any screwing or tightening up, the steam acting through the space around the piston rod, pressing the packing tight. The pistons are fitted with Ramsbottom's springs, and the low pressure piston is very deep, so as to give large wearing surfaces, as it acts in the place of the ordinary crosshead. The cover of the cylinder H has a long slot, so as to allow oscillation of the connecting rod. This is almost the only form of compound cylinder that can be put on a portable engine to be worked with one connecting rod, one crank, one excentric, one slide valve, &c., so that there are no more, in fact fewer parts than in the ordinary engine, whilst, at the same time, a long connecting rod is used.

It is obvious, therefore, that this engine presents great advantages over the ordinary compound engines, where the cylinders stand side by side, as there are less wearing parts, and consequently less expensive wear and tear. The makers state that with a 7 horse-power boiler they have been able to keep up steam and water and do the same work with 30 per cent. less fuel than with an ordinary 10 horse-power engine, whilst the weight for drawing is about 30cwt. less. The accompanying illustration shows diagrams taken from this engine.

CRYSTAL PALACE INTERNATIONAL ELECTRIC EXHIBITION, 1882.

We have received the following list of prizes that have been awarded by the jurors to the exhibitors at the late Exhibition held at the Crystal Palace:—

Diplomas of Honour.

(Awarded to exhibitors not competing for trade motives.)

Her Majesty's Postmaster-General. The Secretary for War. The Anglo-American Telegraph Company. The Eastern Telegraph Company. The Telegraph Construction and Maintenance Company. The Submarine Telegraph Company. The South Eastern Railway. The London, Brighton, and South Coast Railway.	For the General Excellence of their Exhibits.

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C. F. Varley.—For his Induction Machine and Condensers.
R. H. Froude.—For Dynamometer.

Gold Medals.

J. R. Voss.—For Induction Machine.
Elkington and Co.—For their Deposition of Gold Alloys and General Excellence.
H. Wiggin and Co.—Improvements in Electro Deposition of Nickel and Cobalt.
The Faure Electric Accumulator Company.—For Faure Battery.
T. A. Edison.—For complete System of Lighting and other Exhibits.
British Electric Light Company.—For Gramme Dynamo Machine and Exhibit.
R. E. Crompton.—For Bürgin Dynamo Machine and Crompton Arc Lamp.
Anglo-American Brush Company.—For Brush Dynamo Machine and Arc Lamp.
Swan's Electric Light Company.—For Incandescent Lamp.
Electric Light and Power Generator Company.—For Weston and Maxim Dynamo Machines and Lamps.
White House Mills.—For Dynamo Machine.
Rowatt and Fyfe.—For Pilsen Arc and Joel Semi-Incandescent Lamps.
G. G. André.—For Arc Lamp and Regulator.
Gerard and Co.—For Arc Lamp.
Davey, Paxman, and Co.—For Steam Engines.
Galloway and Sons.—For Steam Engines.
Marshall and Co.—For Steam Engines.
Robey and Co.—For Steam Engines.
Ransomes, Head, and Jefferies.—For Steam Engines.
Hornsby and Sons.—For Steam Engines.
E. S. Hindley.—For Steam Engines.
Crossley Brothers.—For Otto Gas Engine.
Thomson, Sterne and Co.—For Clerk's Gas Engine.
Roos and Ostrogovich.—For their Application of the Automatic System to Hughes' Type Printing Apparatus.
Johnson and Phillips.—For the General Excellence of their Exhibits.
Direct United States Cable Company.—For the Excellence of their Exhibits.
Edward B. Bright.—For his Fire Alarm System.
The Exchange Telegraph Company.—For the General Excellence of their Exhibits.
Professor Dolbear.—For his New Electrostatic Telephone.

Silver Medals.

Coxeter and Sons.—Class X.
W. Elmore.—Class XI.
United Asbestos Company.—Class XIII.
J. and H. Gwynne.—For Steam Engines.
Fyfe and Main.—For Arc Lamp.
National Electric Light Company.—For Dynamo Machine and Lamps.
Gravier and Co.—For Arc Lamp and Exhibit.
R. Hodson.—For Steam Engines.
Hammond Electric Light Company.—For Installation of Brush Machines and Lamps.
A. Cance.—For Arc Lamp.
Domestic Electric Lighting Company.—For the General Exhibit.
Electric Lighting Supply Company.
Electric Lighting Engineering Company.
Strode and Co.
W. Ladd and Co.—For Early Historical Dynamo Machine.
W. J. Hammer.—For Historical Collection of Incandescent Lamps.
W. T. Henley.—For his Cable Core.
W. R. Sykes.—For his Electric Locking and Blocking System of Railway Signals.
The Consolidated Telephone Construction and Maintenance Company.—For the General Excellence of their Exhibits.
Saxby and Farmer.—For their Railway Signals.
R. Johnson and Nephew.—For their Iron Wire Exhibit.
F. Smith and Co.—For their Iron Wire Exhibit.
R. S. Newall and Co.—For the General Excellence of their Exhibit.
W. T. Glover and Co.—For the General Excellence of their Exhibit.
Phillips Brothers.—For the General Excellence of their Exhibit.
Professor Monnier.—For his Detector and Analyser of Fire Damp.
J. W. Gray and Sons.—For the Excellence of their Exhibit.
Sanderson and Co.—For the Excellence of their Exhibit.

Bronze Medals.

Binko and Co.—For their Improved Agglomerate Battery.
E. Dent and Co.—For their Non-Magnetising Watches.
E. Paterson.
G. Skrivanoff.—For his Dry Battery.
R. Webster.—For his Non-Magnetising Watches.
Roth, Schlaefli, and Co.—For their Electric Self-Winding Clocks.
J. F. Pratt.—Class X.
H. Whiteside Cook.—For his Electric Governor for Screw Marine Engines.
Arnold and Sons.—Class X.
L. H. Borrell.—For Electric Self-Winding Remontoire Clock.
T. R. Brailsford.—For Water-Level Indicator.
J. Storer.—For Electrical Table Fountain.
J. Willing.—For Electrical Signs.
B. Verity and Sons.—For Brasswork.
G. Hawkes and Co.
Zanni and Co.
E. Muller.
E. Blouzon.
C. R. Goodwin.
Mignon and Co.
J. E. Liardet.
A. R. Sennett.
J. H. Athole Macdonald.
Philadelphia Dynamic Co.
Alfred Apps.
J. E. and S. Spencer.
Julius Sax.
W. Groves.
Doulton and Co.
Automatic Telegraph Company.
J. Davis and Co.
School of Submarine Telegraphy.
Electric Railway Signal Company.
G. C. Lewis and Son.
Waterlow and Sons.

ELECTROMANIA.

We take the following from an article by Mr. Mattieu Williams in *Knowledge*, for July 21:—

More than thirty years ago three of the largest streets of St. Petersburg—the Newski Prospect, the Erbson Strasse, and the Wosneseuski Prospect—were lighted by one lamp placed on the tower of the Admiralty Buildings. In 1854 the works for the construction of the Napoleon Docks at Rouen were illuminated with the electric light, and 800 men worked there during the night as in daylight. Wagner estimated the cost at three farthings per man for three or four hours, or about 17s. per hour altogether. During the last quarter of a century electric lights have been used in lighthouses on our own and the French coasts, and continue in use, the old arrangements still existing in spite of the prospectuses of the companies that are now angling so successfully for investing victims.

The sober, unvarnished fact is that electric lighting has made far less progress during the last thirty or forty years than any other mode of lighting now in practical existence. Gas-lighting, as already stated, has far outstripped it in the primary matter of economy of production. Rushlights and

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tallow dips have been superseded by paraffin candles, and snuffers and snuffer-trays are becoming objects of interest to antiquarian collectors. The modern paraffin candles now sold retail at 6d. per pound are superior to the wax and spermaceti candles that were used thirty years ago, and cost 2s. 6d. to 3s. 6d. per pound.

Middle-aged men remember the rushlights, the tallow dips, the mould candles, and the sperm oil lamps, then the "solar" lamps, then the colza oil lamps, then the "camphine" lamps, the Carcel lamps, and the moderator lamps, all of which are now practically superseded by the single, the duplex, and the triplex mineral oil lamps.

The electric lamp has alone stood still since 1846. Starr tried, and I witnessed his trials of the arc principle, with a score of devices for remedying the flickering, and he did remedy it more effectually than it is now remedied on the Thames Embankment; but he wisely abandoned the arc principle altogether. He did this because, as he explained, the arc light is simply a result of the incandescence of particles of carbon transferred from one pencil to the other, and therefore it would be better to have a solid incandescent stick or filament heated in vacuo, or in carbonic acid or nitrogen. The specification was sealed Nov. 24, 1845. A drawing of the apparatus and a description may be found in the *Mechanics' Magazine* for April 25, 1846, and a letter from myself discussing previous claims for the idea of an incandescent electric light in the same magazine, May 9, 1846.

The order of Starr's progress was curiously like that of Edison, who, throwing overboard the arc light, made his first step with incandescent solids by using a platinum wire and a strip of platinum foil, then an alloy of platinum and iridium. This *novelty* was loudly cried up in the newspapers three or four years ago, but it collapsed. Then came the burnt cardboard, which was but a repetition of another abandoned step of Starr's progress. This effort of "The Wizard of Menlo Park" was so well puffed, that the shares of the company ran up from 30 dollars to 3,500 dollars each, and of course collapsed in the usual manner.

The cardboard incantation of the Wizard being exhausted, another followed—viz., the bamboo—which, as above explained, had also been tried thirty-five years before by Starr; but, in these days of improved commercial enterprise, it has "floated" its companies on both sides of the Atlantic. When it has done its work, we shall probably hear of a further improvement, another great inspiration, viz., the re-invention of Starr's final gas-coke carbon stick, which is incomparably superior to any of the incandescent devices at present flaunted in the joint-stock market.

Edison will not be able to patent this in America, seeing that he was refused a patent for the platino-iridum idea on the ground of Starr's previous inventions patented by King; but in this country anybody may re-patent any invention, however old, and, therefore, when the now popular bits of thread are burnt out, more companies may be built upon the harder, and far more durable gas carbon.

I have already heard of patents for a slight modification of this, which is formed not by burning away the hydrogen compounds from solid vegetable matter, such as wood, coal, bamboo, &c., but by *precipitating* carbon from a gaseous compound of hydrogen and carbon. In the gas retorts this is effected by the hydro-carbon gas coming in contact with the red-hot walls of the retort. In the forthcoming improvements on the incandescent electric light it will be done by filling the electric lamp glass with hydro-carbon vapour, and then precipitating its carbon on the thread of carbon rendered incandescent by the current.

Our old experience of 1845-6 proved that this will be a real step in advance, as the carbon thus precipitated is so much more durable than any of the forms at present in use.

The above was written about three months ago, and I have held it back hoping that the electromania would have died a natural death ere this, but it has now attained such a magnitude, and some of the prospectuses of new companies and extensions are so atrocious, that to remain silent when one has anything to say, and an opportunity of saying it, is almost equivalent to passive co-operation in the conspiracies.

One more appeal to the common sense of intending investors in these companies. Granting, as we all fairly may, that the electric light is admirably suited for lighthouses, for theatres, for *fêtes*, for such works as those of the Napoleon Docks, for tunnel excavators, for the British Museum reading room, and other special purposes where cost is not an object, do we require companies with hundreds of thousands of capital to light these places? Do we require any companies at all?

The nature of the practical requirements for electric lighting prove that we do not. All that is needed is a steam engine, a "dynamo" machine, the lamps, and connecting wires. These can be supplied by private firms, and can be worked on the premises far more economically than from a distance by any great central machine distributing its power to various places. Such distribution demands expensive arrangements of conducting wires, and is accompanied with an amount of loss proportionate to the distance of transfer and the number of sub-divisions.

At the Polytechnic we had an engine that pumped the water, worked the fountains and models, and, whenever we required the electric light or worked the electric railway, we simply connected with it the dynamo (a little machine by the side of the engine) and the wires for the light, &c., by means of their proper binding screws. The like may be done on board of steam-packets, in factories, mines, &c., or where-ever steam-engines are in use. Those who believe that electricity is to make such progress that it shall supply the light and power of the future should be sufficiently logical to perceive that this progress must supersede all existing inventions, and therefore that the four millions that have been recently paid for the shares and the patent rights, and for the promotion of existing companies has been all thrown away. Ninety-nine per cent. of the patents that have recently been specified at the rate of ten to twenty per week are worthless repetitions of old inventions or delusions altogether.

Luxurious people who choose to pay for lighting their drawing rooms by electricity may easily do so by means of a little gas-engine and dynamo, worked in the back kitchen or butler's pantry. They have no more need to apply to a company with a capital of £800,000 for such a purpose than has a hairdresser to do so for supplying the motive power to his rotary hair-brushing machine.

ON THE FUTURE OF ELECTRIC LIGHTING.*

BY ST. GEORGE LANE-FOX.

(CONCLUDED FROM PAGE 258.)

To avoid the necessity of adjusting the plant at the central station and the mains and submains to a maximum, and to avoid also the entire dependence of the district upon the central station for a supply, I propose to set up at various points in the district, and in connection, on the one hand, with the mains and submains, and, on the other hand, with the earth, secondary batteries as reservoirs of electrical energy. These batteries may be distributed at pleasure, and according to the exigencies of the case. Their action, assuming the plant at the central station and the mains and submains to be adjusted to an average supply only, would be as follows:—The dynamos would work night and day. The current in the day time, when not many lamps are in use, would be brought to a stop at the lamps at which the taps were turned against it. The current, not finding any outlet, would accumulate in the system until it acquired a pressure sufficient to overcome the pressure of the secondary batteries. And here I must explain that a secondary battery offers a certain resistance, dependent upon the number of its cells, to the passage through it of the electric current. This resistance can be fixed in any battery in the system, so that it shall not be overcome until the pressure of the current seeking to enter has attained a certain superior intensity. This intensity, then, being reached, the current will enter the battery, and passing through it to the earth, will produce those effects which I have already described, and the energy of the current will be stored up in the battery in the form of its chemical equivalent. Later in the day, and in the evening, when more and

* A paper read before the Royal Institution, May 17, 1882.

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more lamps are brought into use, the current will cease to seek an entrance into the batteries, and will make its way through the new openings afforded to it at the various lamps. Finally at night, when a great demand is made upon the current for all the lamps which may then be lit, a demand which the engines as adjusted could not alone meet, the pressure at the batteries will be removed, and the electrical energy which has been stored up in them during the day will issue out, and will supplement the current which is being supplied to the lamps from the central station. This supplemental current is now independent of the central station, and will flow on, though the latter should be entirely disconnected from the system.

It is in this way that I hope in my system to avoid the cost of a great central station erected to supply the maximum quantity of electricity that can ever be required, and at the same time to insure a constant supply of the electrical energy.

I have now to describe the mode in which I attach the lamps, and constitute the return portion of the external circuit. And here I would pause to sketch what I conceive will be the probable division of labour and proprietorship in the installation of a system of electric lighting.

I think that all I have hitherto described, with the exception of the wires inside the houses, which I may call the house-wires, will certainly be, if not the original work, at least the property of one company, corporation, or person. It may be that the erection of the central station and of all that pertains to it, and of the lamps in public places, will be the work of one set of contractors, and that the laying down of the mains, submains, branches, and subbranches, together with the secondary batteries, will be the work of another set of contractors, and that finally the introduction of wires and lamps into houses will be the work of another set of persons corresponding to the retail gasfitters. But it is probable that when once constructed all the works which may be characterised as out of doors, viz., the central station, the distributing network of mains, submains, and branches, together with the lamps in the streets, and their return connections, will be the property of, and will be maintained by, one set of persons, whilst all the works which may be characterised as indoors will be the property of, and will be set up and maintained by, the owners of the houses, precisely as gas pipes and gas fittings are at the present moment.

We will assume then that the outward portion of the out-of-door external circuit, with its mains, submains, branches, and subbranches, has been laid down in all the streets and to all the houses where the light is intended to be used. It is now necessary to extend the outward portion of the indoor external circuit, to attach the lamps, indoors and out-of-doors, and to constitute the homeward or return portion of the external circuit.

I have said that the size of the wire or branch introduced into a house will depend on the size of the house, and the number of lights which it is intended to have. From this branch, as from a main, a system of subbranches and wires will be led all over the house, and into all the rooms and offices where it is proposed to have the light. Our outward portion of the external circuit is now complete; it remains only to attach the lamps, and to constitute the return.

I will take a single house as an illustration. The mode of fixing the lamps and of constituting the return is the same everywhere, both indoors and out of doors, and what I am about to say will apply equally to all portions of the district.

I must here call your attention to an important feature of the system I am now describing, which I have not yet alluded to—I mean the constancy of the electromotive force, or of the pressure of the current at the various points of the system. In order that the lamp-fitter may know what kind of lamp to use, and that the lamp, when fixed, may always have just the requisite amount and strength of current to make it properly incandescent, and not either more or less, I propose that the electromotive force, or, as it may otherwise be expressed, that the pressure of the current shall always be as far as possible constant, whatever may be the demands upon the current at the various outlets of the system in respect of quantity. I do not mean that the pressure shall at all points be the same—that is not necessary, nor, perhaps, is it possible—but that the pressure at any one point shall, as far as is possible, be always the same. The mode in which I propose to ensure this I will explain by and by. For the moment it is enough if I mention the fact. The pressure, then, of the electric current at the point where it enters the house will be ascertained by the lamp-fitter; it will probably be registered on the wire itself, and he will choose his lamps accordingly. Each lamp made according to my invention bears upon it the particulars requisite to assist him in his choice, viz., both the candle-power of the lamp and the strength of current necessary to make the lamp incandescent. The lamps having been selected, the mode in which they shall be arranged is the next question. They may be arranged either in groups, like the gas jets in a chandelier, or in series along a frieze, or separately, one by one, like ordinary gaslights, lamps, or candles. They may also be arranged so that they shall be lighted or extinguished simultaneously or separately. In any case the mode of fixing the lamp and completing for it the return or homeward portion of the circuit is essentially the same, and is as follows:—I have described to you the incandescent lamp. It will be bought or supplied complete. It will be found to have two copper wires or terminals proceeding from the neck of the lamp, and in contact or electrical communication with the filament of carbon hermetically sealed within the globe. To fix the lamp, or join it up in circuit, one of the terminals of the lamp—it is immaterial which—is attached to the wire already in the room proceeding from the central station, and the other terminal is connected with an uninsulated conductor in communication also with the central station. This conductor will usually be found ready to hand in the form of a water-pipe. Where such does not exist, the wire will have to be prolonged, if necessary, until it can be attached to something which is a good conductor and in contact with the earth. In all cases I should propose to use the earth, in some way or other, as a portion of the return of the external circuit. It serves the purpose perfectly well, and it is, of course, much less expensive and troublesome than a conductor, a wire, for instance, made for the purpose, though of course the latter can be made and be supplied from the central station, together with outward bound wire or insulated conductor if preferred. Such is the mode, a perfectly simple one as will be seen, in which the lamps will have to be fitted on to the electrical communications in the house. The return circuits of all the lamps in the house, I ought perhaps to add, may first be brought together, if that be more convenient, and then be collectively connected with some single return conductor such as I have mentioned.

It remains now to describe the way in which the current is controlled, so that it shall pass through a given lamp or series of lamps, or be arrested at pleasure. This will be immediately understood if it is remembered that, for a current to pass at all, there must be a completed circuit. Every lamp, when incandescent, is in a circuit; that is, its filament of carbon forms part of a complete circuit, which may be described as being composed of the internal circuit of the dynamo machine, and of a portion, complete in itself, of the entire external circuit. Thus, the component parts of such a circuit will be internal circuit, and of the external circuit, main, submain, branch, subbranch, we will suppose, wire into house, wire upon which lamp is fixed, lamp itself, return wire of lamp, return of system, and so on back to the other pole of the external circuit. Now, if this circuit is broken at any point of the external circuit between the dynamo and the lamp, the lamp will be extinguished; so if the connection be restored, the lamp will, assuming the dynamo or the reservoir to be at work, again and instantly become incandescent. An apparatus, then, resembling an ordinary gas tap, may be put up at any point or points in such portion of the circuit, and it will control all the lamps which lie beyond it. The circuit may be broken and restored at pleasure by such means at the central station, at any point or points of the mains, submains, and branches, at the entrance of the wire into the house, an arrangement which would control all the lamps in the house, and at any point between such last mentioned point and any lamp, group, or series of lamps which it may be desirable to control in a group, a series, or singly. The apparatus consists only of a device for breaking and reconstituting the circuit.

I have now described the system of distribution so far as relates to the central station, the mains, submains, and branches, the secondary batteries, the lamps, and the return portions of the circuit. I have yet to say a few words about (1) the means for keeping the electromotive force of the electric conducting mains constant, and (2) the means for measuring the quantity of the electricity used.

The electric current may be conceived of as the still electricity of a completed circuit set in motion in endless rotation around the circuit, more or less of the electricity resident like tranquil air in the system being set in motion according as more or less power is brought to bear upon it. Now, assuming that in a given circuit a given power sets a given quantity of electricity in motion with a given pressure, it is obvious that if that circuit be extended, the current in motion will be distributed over a wider area and will flow, the force producing it remaining the same, in shallower streams, so to speak, and with diminished energy. Hence, as in any system of distribution such as I have described, the circuit is perpetually changing in extent, now at night, now in the daytime, by the addition and withdrawal of the particular circuits upon which particular lamps or set of lamps are placed, a circuit being added or developed when a lamp is lit, and withdrawn or choked up when the lamp is extinguished, it is apparent that if the pressure of the current at any point, as at any lamp

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for instance, is to remain constant, some means must be at hand for increasing and diminishing, in exact proportion to the demand, the power to which is due the motion of the electricity in the entire system. These means are (1) additional generators or dynamos, (2) secondary batteries, and (3) a regulator or apparatus specially constructed for the purpose. By these means severally, or, best in combination, the power can always be adjusted to the exigencies of the case, and, however variable the demands upon it may be, the energy of the current at any point be kept practically constant.

The measurement of the quantity of electricity used, *i.e.*, of the quantity of electricity which has passed any particular point, presents no insuperable difficulty. I have an electrical meter here which is constructed for that purpose. It is not perfect yet; it is too complicated. I have no doubt, however, that in a very short time it will be perfected, so as at least to be fit to make a start with. I need not explain it in detail. It will be sufficient, perhaps, if I explain the principle upon which it and all such meters are constructed. The only difficulty is in the application of the principle, and that, as I have said, is not in any way insuperable; it requires only a little time and thought to be overcome completely. The principle, then, is this. The movement of that which has to be measured has to be translated into a movement of something which will vary precisely with itself, and at the same time leave a visible, legible, record of the movement which has been accomplished. This translation will be readily understood if you recall to mind how the movement of the wind is recorded upon a diagram by lines which rise and fall with its pressure, and how other quantities, variable in degree, may be so adjusted as to make their variation tell upon an indicator, which in its turn shall leave a permanent record of the amount of variation to which it has been subject. And you will remember how in the system now under description one kind of force has already been translated into another in the production of the electric current by means of mechanical motion. The meter, when perfected, would be put up at whatever point or points it was desired to know the quantity of electricity which had passed that point. For instance, a meter at the central station could be made to measure the quantity supplied to the entire district served by that station, a meter at the mouth of a secondary battery could be made to measure the quantity which had gone into or had come out of that battery, and a meter in a house could be made to measure the quantity which had been supplied to that house. The meter, in order to measure the current, would have, of course, to be constituted a part of a circuit, or to be placed upon a shunt, as it is called—that is, upon a branch circuit so constructed that a definite proportion of the total current requiring to be measured shall flow through it.

I have now, to the trial of your patience, I am afraid, described how I conceive the electric current may in any district be distributed and be brought to the houses of the consumers without any other trouble in kind, and with much less, I think, in degree, than is incident to the consumption by them of gas. The householder will have the current laid on to his house at a known and constant pressure day and night. He will be able to determine for himself to what extent, in what rooms, and in what modes, and to what purpose he will apply it. And he will be able to choose for himself the particular lamps, whether Edison's, Maxim's, Swan's, or my own, which he may deem best suitable for his purpose. He will be left at perfect liberty. The only demand upon him will be a demand from the central station for the price of the quantity of electricity which the meter in his house may record against him. And I may leave this part of my subject with the expression of my hope and belief that that quantity will ere very long be found to be in every case very large indeed.

Now, I should like, if you will allow me, to go into the third question, the question, viz., of the economy of electricity as compared with gas. I may first say that my reason for believing that the incandescent lamp will ultimately supersede the arc depends not only on its great superiority in point of convenience and easy management and steadiness, and the fact that its light has no colour, but I believe that in time it will actually prove to be more economical. In the arc light it is necessary to remove the carbon pencils from time to time as they burn away. This removal is expensive, requiring, as it does, skilled labour for the purpose. An incandescent lamp once mounted requires no attention, and if properly made will last so long good that its cost may be thrown out of account in any estimate that may be made of the comparative economy of electricity and gas when that lamp is used. This gives the incandescent lamp a great advantage over the arc. In the estimate I am about to make I shall assume that the former lamp is used, and I shall not take its cost into the account. I must premise that, of course, we have not got actual results to go by on a scale anything comparable to gas-works, so that we cannot give figures of what has been done. Still, I think our knowledge of the subject justifies me in drawing some conclusions. We know that by the expenditure of a certain amount of fuel we can produce a certain amount of power. We know that on a large scale, and with good machinery, a combustion of 1¾lb. of coal will yield one horse-power for an hour, and we know what one horse-power will do in producing light by incandescence; we know that that amount of energy expended in raising a certain extent of surface, whether continuous or broken up into several lamps, to a certain temperature, will produce a total light equal to 150 candles. Knowing, then, that an expenditure of one horse-power is about equal to an expenditure of 1¾lb. of coal per hour, and that by the expenditure of one horse-power we can get a total light of 150 candles, we can calculate on that as a basis. Supposing that we took the cost of fuel to be about one-third of the total cost or expenditure for the production of energy—and I think we may fairly assume that, if we take the case of very large works, works on a really large scale—we could then retail energy at one farthing an hour per horse-power, that is to say, we could actually produce the power, and sell it at a profit at that price. It seems a low figure, but if we remember we are to have works for the sole purpose of developing energy, the cost will surely be very much lower than where the actual production of power is quite a subsidiary matter, as it is in ordinary factories. I say that a farthing is a very fair estimate of the cost of horse-power per hour. I wish to press that matter very strongly, because the result I am going to arrive at is very astonishing. An ordinary gas jet, burning five cubic feet per hour, taking an average price, costs one farthing per hour. Now I have shown that energy can be produced at the rate of one farthing per hour per horse-power, and that will produce light equal to 150 candles. An ordinary gas jet is equal to twelve candles only, so that for the same price twelve times as much light can be produced electrically as by gas. Probably that seems an extraordinary result, but it is within the region of probability.

I should like before concluding to show how far electricity can be used for other purposes besides lighting. We have already seen that one horse-power per hour can be produced at a certain price—one farthing—and this represents a certain amount of heating energy, which can be utilised in any way you please. It may be used to raise a lower temperature to a higher in the case of water, coffee, chocolate, and so forth. Here is a cylindrical cup or apparatus [describing], consisting of one cylinder enclosed in another, intended for that purpose. There are two terminals, one to be connected with the main, the other with a return conductor. On making connection with the main the current would pass through a length of wire coiled round the outside of the inner cylinder, and between it and the outer cylinder, the two cylinders together forming the sides of the vessel. The larger portion of the heat-energy would be absorbed by the inner cylinder, and the inner surface of the vessel would become hot. If there is a liquid inside the vessel, that liquid would take up the heat. The wire is surrounded on the outside by flannel or felt, so that the heat may not be lost by radiation to the outer cylinder, which, again, protects the flannel or felt, and keeps it from wearing away.

This particular apparatus holds, I think, about a quart, and the energy which would have to be expended upon four of these incandescent lamps would be sufficient to make it boil in about five or six minutes. Now, if we imagine for an instant what that really means, we can see that the cost will be very small indeed. The energy requisite for the incandescence of four lamps for a few minutes would be much cheaper than gas—would be, indeed, next to nothing. I believe in the not distant future we shall have an apparatus similar to this in construction in all our kitchens for boiling, stewing, or roasting, or any other kitchen purpose.

I should also like, had I time, to refer to the application of electricity to motion, but I do not think that I can venture to go into that now. We know, however, that there are certain useful forms which electricity can take, such as light, heat, and development of motive power; and when once we have got electricity laid on to our houses we shall find these, and perhaps a great many more uses for it. We can hardly imagine the changes it will introduce into our daily life; one thing is that it will save us all a great deal of time. We shall have no trouble in the lighting by electricity as we have with gas; we shall have always only to turn a cock to have it on or off; it will be always ready at any moment if we have a proper system of distribution and storage; and so I can imagine that when once it is in the hands of the public they will make good use of it, and find many other applications for it which have not yet been found. It is really only a matter of time how long or how soon this extraordinary change will come about.

I thank you very much for having so patiently listened to me.

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WITH AND WITHOUT THE TELEGRAPH.

Some very impressive words uttered the other day by the Chairman of the Eastern Telegraph Company in reference to our existing means of communication with the East have again recalled public attention to the extraordinary part played by submarine telegraphy in the development of commerce and civilisation. With regard to the commercial aspect of the question Mr. Pender is eminently qualified to speak, for he has long been identified with telegraphic enterprise, and the financial results, which afford an excellent index to the commercial results attending them, must be known to him better than to most men. The effect, as he says, of losing, or of even being temporarily deprived of, our links of communication with the chief seats of the world's commercial relations would be simply disastrous. We have already grown so accustomed to the certainty of buying and selling, and of financially negotiating by cable—in fact, have come so to regard the whole world as if every place in it of any account were, so to speak, next door to us, that the condition of things which would immediately supervene were we to be reduced to the *status quo ante* is now, perhaps, hardly ever seriously contemplated. A reminder as to contingent possibilities, and what they would entail upon us as a commercial people, was not altogether ill-timed at a moment like the present.

In this relation it is worth while to remember that submarine telegraphy has not yet experienced the strain of a great maritime war. Since the invention of the telegraph, indeed, war has rather contributed to the increase of submarine cables; it has not yet occasioned their destruction to any appreciable extent. England is the chief maritime nation and the chief of cable proprietors, and England has not been involved in a war with any civilised country—we beg the royal gentleman's pardon who has just arrived at Holland Park—for at least a quarter of a century. Cetewayo and Ayoub Khan were quite capable of cutting a submarine cable had it come in their way, no doubt; but their appreciation of telegraph wire in general was measured chiefly by its value as old iron, and while they confined their depredations to acts which could easily be repaired, we on our part multiplied the means of insuring their permanent discomfiture. But should we come to serious blows with any country comprehended in what is by courtesy termed European civilisation the situation might be considerably altered. The sanctity of our submarine cables would certainly not then be respected, and it may be hoped that nobody in this country supposes that they would. We have no mind to see Mr. Pender cutting the figure of a M. de Lesseps, who apparently thinks he can frighten a British ironclad by virtue of his proprietary rights. There has been no international decision as touching the sanctity of cables, and at times it is difficult to see exactly why they should be rendered neutral. The network of cables in the Mediterranean might, perhaps, be secretly increased by the laying of light lines from various points, and so rendered more safe against organised attack.

The idea of doing anything secretly by this country, however, brings to our recollection some very odd proceedings connected with the present crisis in Egypt. Nobody with a grain of military instinct can fail to notice the liberal, not to say lavish, use of the telegraph made by special correspondents at the scene of operations. Everything that is going to be done, as well as all that has been done, is telegraphed to and published in this country with an openness and candour that might be exceedingly virtuous if it were not so egregiously stupid. The cablegram which comes to England is transmitted to the continent, and so back again *viâ* Turkey in Asia to Egypt; so that in effect Alexandria communicates all its movements to Kafrdawar by way of London, if not by even more direct routes. Without the telegraph we should be seriously hampered; but with the telegraph we may be effectually circumvented if excessive scrupulosity is to prevail. *The Times* correspondent at the seat of war—if we may be permitted to call it so—stated a day or two ago that "Araby is continually informed from England of all that appears in English newspapers;" and the writer justly argues that "if the safety of our fleet demanded the destruction of the Alexandria forts, surely the safety of our armies and fleet demands stringent measures to prevent information being afforded to those with whom England is at war." The telegraph is an exceedingly useful ally; but in the hands of Mr. Blunt and his friends we could very well spare it. No doubt, as we have said, if Araby receives information it is sent very indirectly and reaches him through the continent, so that it is difficult to see how the suggestion of *The Times'* correspondent is to be carried out.

In the hands of the naval and military authorities the telegraph is probably safe from abuse of the kind we have just

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adverted to. Men who are immediately responsible for the lives of our soldiers and sailors are not usually overburned with scruples, and are, happily, removed from the influence of hysterical public opinion at home. Already we hear that it "has been found necessary" to cut the Turkish cable to prevent communication between Araby and the officials of the Porte. Probably the next step will be to cut the land line which affords means of communication between Araby's position and the questionable personages who are sheltered in the Khedive's palace. We are somewhat surprised that this has not been done before now; but it may be taken for granted that so soon as the necessity for it arises in the judgment of the military commanders there will be no hesitation in applying a fitting remedy.

Of the condition in which a country remains which is either wholly or temporarily without a telegraph Egypt just now furnishes us with a painful example. The Egyptian telegraph system, such as it is, evidently does not exist for the Egyptian people. That this is the case is plain from the otherwise incredible credulity displayed by the people who are flocking to the standard of the newly-fledged Mussulman prophet. It is possible, apparently, to satisfy them that a great portion of the British fleet had been sunk when Alexandria was bombarded. They are told, and they seem to believe it, that Tewfik has sold Egypt to the English, and has retired with his family to England. At a great meeting —perhaps it was a mass meeting—held at Cairo, tears were brought to the eyes of the assembled multitude by the recital of the excesses committed by English sailors upon native women of Alexandria. We have no doubt that resolutions were passed unanimously, as is the custom of the divine populace in other places besides Egypt, condemning, for want of truth, the falsehood which it suited their leaders to invent. Judgment always overtakes an unveracity wherever it may be uttered; and even in the land of the Pharaohs hard fact will make its way sooner or later. But meanwhile we have to regret that Egypt is still only a half civilised country, and that the telegraph which freely traverses its waters and its soil has not yet emancipated its inhabitants from the thraldom of pious fraud, or protected them from the deception of reckless ambition.

TELEGRAPHIC COMMUNICATION WITH INDIA.

The Times of August 2, in a short article "from a correspondent," discusses the question of our communication with India. We admit the gravity of the question, but we dispute the conclusions arrived at by the writer. "It would," he says, "be well worth the expense to this country to have, in addition to the route *viâ* Aden, a telegraph line *viâ* the West Coast of Africa, which could be protected by our cruisers, and be free from the risks of the Mediterranean, Egypt, and the Red Sea." The writer is fair enough to state that this question was thoroughly discussed in the columns of *The Times* when it was decided to subsidise the east route cable to Cape colony. The question appears under two aspects (1) a Government cable, or (2) a cable supplied by private enterprise. It seems to us that the decision in either case depends largely upon the prospective business to be transacted over the cable, as well as the sea bottom over which it is proposed to lay the cable. In the case of a cable *viâ* Ascension, the West Coast of Africa, St. Helena, Cape of Good Hope, Mauritius, and India, the amount of business would be comparatively small, altogether insufficient to pay working expenses, dividends, and to form a reserve. We will not say that it would be absolutely impossible to repair such a cable, but the process would be exceedingly expensive, and the success doubtful. Sir Garnet Wolseley may be a good general, and have a very extensive knowledge of submarine telegraphy, but when he says, "These points could be very easily connected by submarine telegraphs; there is no difficulty whatever, so long as we boldly launch out into deep water and there sink our cables," we must beg to differ with him. Men experienced in submarine telegraphy do not care about, nor are they eager to lay cables in the depths of the southern Atlantic. They have always before them the question of "repairs," and prefer to work with a possibility of success. Then, again, protection in the Atlantic would be more difficult than in the Mediterranean. It is not, we believe, the fault of the cable companies that we are dependent solely on the Indo-European line; it is rather the fault of the Government. There need not have been a day's delay in the transmission of messages *viâ* Suez had the Government sanctioned the proposals of the cable companies. The Eastern Company's ss. "Chiltern" and "John Pender" are now off Alexandria with sufficient cable on board to lay a cable through the Suez Canal, and such cable could be laid in at most a couple of days, the total length required being only about 160 miles. Since writing the above a letter from Lieut.-Colonel Bateman-Champain has appeared in *The Times*, in which similar views are stated to those we have expressed. The whole question, however, of the alternative west route was thoroughly discussed not only in *The Times*, but by the management of the cable companies and the Government during the negotions that ended in the laying of the cable *viâ* Aden and Zanzibar to Natal. It may be taken for granted that the reasoning that held then holds now, and that full weight was given to all the accidents that might happen in war or peace to sever our communications. The negotiations now being carried on between the Government, the Suez Canal authorities, and the cable companies will, we believe, end in a satisfactory solution of the problem. If the Government requires a West Coast cable, there is no reason why it should not be laid, providing they are willing to pay for it. We do not believe the country would sanction the expense, however, and especially so, when the many dangers and slight returns were fully explained and considered.

CORRESPONDENCE.

ELECTRIC LIGHTING IN THE CITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the notices which have recently appeared in your journal giving certain figures as to the electric lighting in the City, I beg to state that these statistics, as given, may be very misleading without explanation, as they do not by any means convey to the general reader a fair understanding of the subject. The apparent high percentage of so-called failures or extinctions shown as to the Brush light is almost wholly due to the fact that the lighting was discontinued from the 2nd May, 1881, for a period of 17 days, it having been determined, in consequence of defects which soon appeared in the first cable laid down, to replace it with another. This surely should be estimated as a single failure only (one, too, which had nothing to do with the Brush system, and which could be guarded against for the future), whereas it is reckoned in the figures given in your article as 561 failures, counting each of the 33 unlighted lamps as one failure for each of the 17 nights, during which no lighting was even attempted. This reduces the reported number, 660 failures, to exactly 100, the whole of which arose from causes which (after the experience gained in this, the first large

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attempt ever made at street lighting in this country) are easily remediable. It is worthy also of notice that, although the lamps in question are all on a single circuit, in no one case has an accidental stoppage of the mechanism in one lamp affected any of the others. The 209 hours 30 minutes' extinction through the failure of the driving apparatus occurred at the commencement of the trial, when some necessary alterations were being made to the boilers and other machinery at the factory.

It should be further pointed out that the number of so-called failures was considerably increased by one of the lamp posts being overthrown by a van, causing an extinction of this lamp for 103 hours. Deducting, then, from the gross extinction of 3,142 hours 30 minutes 2,630 hours for relaying the cable, 103 hours for the broken lamp post, and 209 hours for the alterations to boilers, &c., which events are altogether outside any defect in the Brush system of electric lighting, there remain only 200 hours of extinction, spread over a series of 33 lamps, out of the total number of 141,900 lighting hours, being a percentage of ·14 during the whole year of an experimental running, the first of its kind ever attempted in this country.

I would further point out that of these defects the bulk were in the early part of the experiment, and that they have gradually become less and less, pointing to the conclusion that with a little more time and experience we may expect that they will disappear entirely.

Since the continuation of the lighting for the second year the lamps have burnt very regularly, and, so far, we have had no complaints.

I would mention that the subject is very fairly and comprehensively dealt with in the report of the Streets Committee presented by Colonel Haywood.—Yours, &c.,

JAMES HUMPHRYS.

Anglo-American Brush Electric Light Corporation,
Belvedere-road, Lambeth, S.E., August 3, 1882.

THE INDUCTOPHONE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In a recent number of *The Electrician* a description is given of Mr. Willoughby Smith's "Inductophone."

In speaking of this instrument to an inspector of telegraphs here he informed me that effects precisely similar to those produced by the "Inductophone" may be observed by the aid of an induction coil and an ordinary Bell telephone.

To prove this I put in circuit a small Ruhmkorff coil and *one* cell of a Grenet battery, and on applying a Bell telephone (disconnected) to my ear I could distinctly hear the passage of the induced current in the Ruhmkorff coil, even at a distance of two or three yards. If I held the telephone very near to the Ruhmkorff coil, and made the vibrating contact plate move as slowly as possible, the sound in the telephone resembled distant thunder.

I have no doubt but that with a good-sized Ruhmkorff coil effects equal to those produced by the "Inductophone" would be observed.

I have noticed another effect of induction which will, I think, be new to your readers.

If a current from an induction coil is sent through a Geissler tube luminous effects are visible. Now, remove the Geissler tube through which the current has already passed, attach another tube in place of the first one, place this first one very near to the induction coil, and on completing the battery circuit *both* tubes will be luminous, the disconnected one, however, much more faintly so than the one in circuit.

It would seem to be necessary to first pass a current through the Geissler tube in order that some of the current which has not had time to discharge itself may be acted upon.—Yours, &c.,

ALFRED EGGINGTON.

Otranto, Italy.

AMPERE'S MNEMONIC RULE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. W. M. Mordey, of Stamford-street, Blackfriars, tells me that he has for some years known and used the mnemonic "S-N-O-W." that you inserted for me in *The Electrician* of the 8th July. He also informs me of another equally ingenious mnemonic, which may be worth printing:—"If the current flow from *N*orth *O*ver the needle to *S*outh, the north-seeking pole turns *E*ast: Remember N-O-S-E."—Yours, &c.,

S. P. THOMPSON.

FIRE RISKS FROM ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am glad to find that some one has made the attempt to pull to pieces the rules drawn up by the Society of Telegraph Engineers and Electricians, for, although I know something about the subject, I cannot see how those rules can be of any use to any one but a fully qualified electrician; and yet they profess to instruct those of medium qualifications, like myself. Not wishing to contend against such practical experience as Mr. Moseley's, I submit that he ought to give his own views instead of contenting himself with demolishing the work of such a strong committee of electricians. If he has no intention of doing so, he might as well have let the matter rest; but, for my part, I hope that he, or some one else, will more fully explain the necessity of some such rules as are put forward, for I am concerned in some electric lighting where peculiar circumstances raise many doubts in my mind.

In conclusion, let me point out what chiefly prompts me to write. Mr. Moseley says there are "two of the most likely fire risks" that are overlooked by electricians and insurance surveyors; but he mentions one only, and that one seems a barely possible occurrence.—Yours, &c.,

J. PHILLIPS.

Oak Wharf, Millwall, E., August 1, 1882.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I, in common with, no doubt, most of your readers, commenced on Mr. Moseley's letter on the above subject with considerable interest, as I hoped to see some points in the rules usefully commented upon. In this I am signally disappointed. Mr. Moseley, although he is severe in his strictures on the ambiguous or faulty English used in the rules, has himself wrapped up his meaning in such involved language that I must confess I cannot arrive at his meaning, although I have gone over his letter several times.

I cannot resist the temptation to apply his own method of criticism to one of his own sentences. Take the paragraph last but two of his letter.

It stands thus: "When the Wheatstone bridge was first introduced to ascertain at what distance a fault might be found in a submarine cable, the first grand 'Eureka' that came through the discovered fault to announce the correctness of the 'balance' caused many false feelings of security, until it ultimately became known that, if two faults broke out far apart, the indications of 'balance' would direct the repairing ship as far away as possible from both faults. Having had to discover thousands of faults in electric conductors, no one knows better how 'easily the skill is acquired,' but I fail to realise much consolation from the fact, either in view of the consumer's pocket or the reputation of *The Electrician*."

Now, I think that *The Electrician*, although we are assured that it is "not a comic paper," might imitate with advantage the series of puzzles set by some of the Society journals, and offer prizes for the best solutions to the puzzles involved in the above-quoted sentences. For instance, the questions might be put thus:—

1st. What is or was a "grand Eureka," and how much E.M.F. does it take to get it through a fault in a submarine cable?

2nd. Are Eurekas still able to give false feelings of security? If so, an agent of Arabi Pasha is willing to treat for a supply of them.

3rd. Any one who will point out the nominative case, &c.,

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in the last sentence, commencing, "Having had to discover," and ending "Electrician," will receive first prize, a handsome new Eureka at least.

But, joking apart, what does Mr. Moseley mean? Is it that he knows how to acquire skill in detecting faults? If so, what is his object in saying so, unless he wishes to advertise himself as ready to take pupils. But even if this view of his meaning be correct, why should or should not he realise consolation? and why must he realise consolation in full view of two things only, *i.e.*, the consumer's pocket and the reputation of *The Electrician?* I suppose he thinks that these two things are alone to be trusted. I give it up.

If I have dealt disrespectfully with Mr. Moseley's letter it is not because I do not respect his object in wishing to ventilate this matter, but to point out to him how easy it is to criticise, and how easy it is to write bad English.

But could not the majority of his criticisms be answered somewhat as follows?

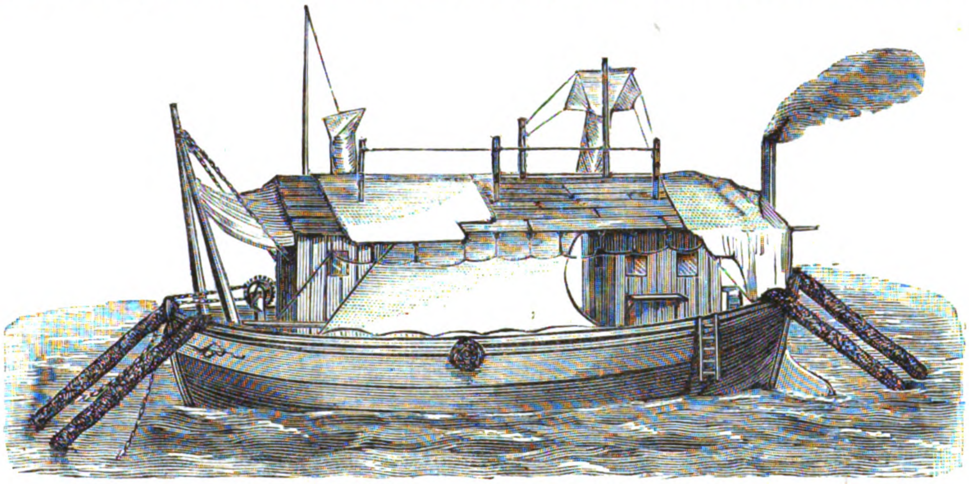
The English of the rules, although in some cases awkward, is not obscure, and its awkwardness is only what one might expect from rules probably originally drafted in good English but afterwards amended in committee.

Again, the omissions complained of—such as that omission of directions how to make the soldering of a joint sound, the best material for capping wires, &c.—are, I think, obviously intentional, as it was no part of the duty of the committee to put into their rules suggestions which might easily be construed into hard and fast rules by too zealous inspectors. Such suggestions might fetter the progress of what is, after all, a very new scientific trade, quite distinct from telegraphy or even electric bell-hanging.—Yours, &c.,

ELECTRIC LIGHT.

CABLE WORK UNDER DIFFICULTIES.

At midnight on the 9th of July the Eastern Company's staff at Suez were requested to leave the town, as their safety was endangered. Foreseeing the necessity of this, for some time previously the work of preparing a floating station had been going on, most of the requisites having been sent on board a lighter. At six a.m. on the 10th the staff left with their personal luggage, and were taken by Captain Chitty in his steam tug to the lighter. Two cables were then grappled and brought on board, and arrangements completed for sending messages. Malta was spoken to at 11:50 on July 10, and Aden at 12:35 a.m. on the 11th. Communication ceased with Malta at 8:12 a.m. on the 11th July, in the midst of a message, and has not yet been renewed. It is interesting to know, and it is exceedingly creditable also to the staff, that it is possible to work the recorder afloat. The instrument is in continuous work on board the boat. So far as we know the recorder has never been so used before. We are able to give a sketch of the lighter in which the work is being carried on. The cables at the stem and stern keep the boat fairly steady, though there is a swinging motion, which, however, does not affect the instruments. The cables are swathed in cotton to protect them from the sun.



Eastern Telegraph Company's Floating Station off Suez.

We may, perhaps, say that at the time of the despatch of the letter from which the information we have given is obtained, the Egyptian land lines were in good order from Suez to Kafrdawar.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).

The tenth ordinary general meeting of this Company was held at the Cannon-street Hotel, on Friday, July 28, under the presidency of Mr. Pender, M.P.

The SECRETARY and TRAFFIC MANAGER (Mr. J. W. Fuller) having read the notice convening the meeting,

The CHAIRMAN said: You have had the report in your hands some time, and I presume you will take it as read. Before making the general remarks which I will do in moving the resolution, I think it is necessary to give you a few figures as showing the working of the system during the past six months. The revenue for the half year to 30th June last, after deducting out payments, amounted to £61,025 8s. 3d., and the working and other expenses, including interest on debentures and income-tax, &c., to £24,979 3s. 2d., leaving a balance of £36,046 5s. 1d. as the net profit of the half year, making, with £4,623 0s. 8d. brought from the previous half year, a total of £40,669 5s. 9d., which has been appropriated as follows:—Interim dividend of 5s. per share, to 31st March last, £15,177 10s.; final dividend of 5s. per share, to 30th June, now proposed, £15,177 10s.; carried to reserve fund, £9,531 9s. 1d.; written off preliminary and arbitration expenses, £500; and carried forward to next half-year, £282 16s. 8d. —total, £40,669 5s. 9d. Owing to the 1s. tariff the revenue is much less than in the corresponding period of 1881, when the tariff was 2s. per word. It was hoped, when the 1s. rate was adopted, that the traffic would respond to the reduced rate, but ten months trial of that rate has proved it to be unremunerative. The American Telegraph and Cable Company opened one cable at a tariff of 2s. per word on the 15th May last, and that tariff has been in force over the other cables since the 22nd May. The second cable of the American Company was opened on the 30th ultimo, and that company has accordingly participated in the joint traffic receipts in respect of one cable, as from the 15th May, and in respect of two cables, as from the 30th June, in the proportions agreed upon. It may here be mentioned that the agreement entered into with the Land Company on the American side is working well, and the benefit of reduced expenses secured by the arrangements will be seen in our future half-yearly accounts. Proceeding to the expenditure it will be observed that while most of the items have either been reduced or remain practically the same as last year, there are one or two increased amounts. Stations—salaries, &c., for instance, stand for an increase of £903. This is accounted for by the engagement of additional clerks in the December half year, under circumstances fully explained to the meeting on 27th February last. On comparing this item with the December accounts, however, it will be found to show a reduction of £291. In printing, stationery, and advertising the increases of £48 in London and £202 at stations are wholly accounted for by the increased consumption of message forms and other stationery through the low tariff, and by advertising and otherwise notifying the return to the 2s. rate. On the whole, however, the expenditure has been £1,893 less than in the corresponding period of 1881. During the financial year just ended, we have paid a dividend of 5 per cent. to the shareholders and added £29,000 to the reserve fund, but it is only by the aid of two months at the 2s. tariff that this result has been

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obtained. Therefore, with all our desire to maintain the shilling rate it would not pay. That is the real business expression—it would not pay. When I last had the pleasure of addressing you it was to ask your approval of a working arrangement with the American Telegraph and Cable Company, and with the Western Union Telegraph Company of America. Those arrangements are now in force, and, as you are aware, the combined companies are now working under a 2s. tariff, and the two cables of the American Company are now in operation, so that at the present moment the combined companies have no less than eight cables across the Atlantic, and when all those cables are in good working order and duplexed, they would for all practical purposes be equal to double that number; so that, comparing the carrying power of the cables with the traffic, there is a large surplus of carrying power equal to any growth of traffic that is likely to occur for a considerable period. Now, Gentlemen, if we had felt that we could have employed the surplus carrying power at the 1s. rate we would not have reverted to the 2s. tariff, but after an experiment, which was fairly and honestly conducted, we found that the percentage of progress was so small that we were obliged to return to the 2s. rate. Had we not done so I should not have had the pleasure of submitting to you the dividend which I now recommend. Do not misunderstand me—I believe there is a considerable growth in submarine telegraphy; but it has arrived at that point which is slow compared to the bounds it has made during the last twelve years; and so far as figures prove anything it would have taken us, under a 1s. rate, at least four or five years before we could have secured the return which we now do under the 2s. rate. This would have involved a loss of something like one and a half to two millions sterling. Looking to the fact that your dividends have never been large, and to the enormous benefit which these telegraphs have conferred upon the commercial, as well as the political and social life of the world, I think it would be asking too much of the shareholders in these companies to give up for a term of years the dividend to which, moderate as it is, they are fairly entitled. In my previous addresses to you at these half-yearly meetings I have given you much information and have placed before you many figures on the subject of telegraphy. On the last occasion I proved to you by figures that the 1s. tariff was not sufficiently remunerative, even upon the reduced price at which telegraph property can be bought to-day, because the theme is that our stocks are watered; but if you take the cables now laid and working well, they could not be relaid for the amount of capital represented by the market values of the respective companies' stock—not to speak of the large reserves held by some of them. That, therefore, puts the question of watering entirely aside. The value of a thing is what it will bring in the market, and the price in the market today, with a 1s. tariff, would not have given anything like a return on the investment. But, notwithstanding all this, the Atlantic seems to be a great field for enterprise, and the more uncertain, the more mysterious, the more undefined, and the more risky operations are, they seem to be just the very things to attract the company promoter and command more attention than those enterprises which are sound and easily understood. For instance, we are now threatened with two additional cable companies in the Atlantic. One of them (the European, Canadian, &c., Company) I think destroys itself by the fallacy of its own figures. A letter addressed to *The Times* by Mr. Weaver, of the Anglo Company, proves this, and I think there can be no harm in my calling the attention of the public and the shareholders of this Company to the subject. Their position, I believe, would be this: Assuming their two cables to obtain their full proportion, or one-fifth of a total estimated traffic of 16,000,000 words per annum, they would have to carry 3,200,000 words, which at 9d. per word would yield £120,000, an amount that would fall far short of their requirements for working expenses, reserve fund, paids-out and repairs. If we take their own figures and put the working expenses and paids-out at £80,000 and the renewal fund at £45,000 (which, by the way, is not by any means sufficient) the result would be that instead of the profit set forth in their prospectus there would be a loss of £5,000; but it is necessary to draw attention here to the statement that in this said sum of £80,000 the paids-out, that is to say the amount to be paid away for land line transmission in the United States, Canada, and England are included. Now this paid-out, reckoned at only 1½d. per word, would absorb £20,000. But reckoning such out-payment at 3d. per word, and that is what I believe they would find to be the lowest average, it would absorb £40,000. But, however treated, there is no doubt as to their working resulting in loss instead of profit at the price they profess to work at. Nor is special provision made for cost of repairing interruptions to their cables, which are certain to occur. We know what they have cost this Company and all other similar enterprises. Why, it cost £90,000 during the first three years of this Company for repairing one cable only. That is an item this new company has entirely left out of calculation. With regard to their proposed adoption of the "Mutual" principle, let me suggest that possibly this "mutual support" system might resolve itself into a "mutual subscription" system, in order to make up the loss which would certainly fall upon those who entered into a mutual obligation enterprise Rumours of new telegraph companies seem to be cropping up every day. Stock Exchange speculators, no doubt, have a good deal to say on these reports, because they are a handle for depressing the Stock Market; but those who have placed their money in them for investment had better wait. I would say, do not be afraid or run away on account of reports circulated by interested motives. The low prices will eventually strengthen these companies by bringing in a large number of *bonâ fide* investors, who will reap the advantage; but it is my duty, on an occasion like this, to warn our own shareholders not to be alarmed, but to rest satisfied that those who are watching over their affairs will take good care that they will be fully looked after, and that the shareholders will be well informed and advised whenever occasion renders it necessary. There is no question at all in my mind that the combination consisting of the associated cable companies and of the Western Union Telegraph system of America, will carry under any circumstances the bulk of the traffic, and, for the best of all reasons, that they will be able, with the important means at their command, to deal with it more expeditiously than any new competing company, and speed in telegraphing, which means time to the commercial man, is to him the important factor in his transactions by telegraph. I have put these remarks before you because the submarine system now has become so very important that it has become for the world a great necessity, and it would be a grave misfortune if through speculative purposes a property or a system which is so beneficial to the world at large should be discredited by men whose only object is to get a little money out of contracts in the first instance. I trust that telegraphy is on a sounder basis, and those who have ventured into this particular class of property have the satisfaction of knowing that it is now a recognised property, and that the amount of benefit they derive from it—though not large in itself at present—is likely to continue to be so developed and matured that it will become a sound investment for them, while for the world it is really indispensable. With these remarks, I beg to move:—"That the report of the directors, dated 19th July, 1882, together with the statement of accounts to the 30th June, 1882, annexed thereto, be and the same are hereby adopted; and that a final dividend be now declared of 5s. per share, free of income-tax, making, with the interim dividends already paid, a total dividend of 5 per cent. for the year ending June 30, 1882."

Mr. W. FORD: I beg to second that.

The resolution was put to the meeting and carried unanimously.

Mr. JACKSON: There is one remark I should like to make with regard to the accounts. I should like to see the amount of preliminary expenses cleared off. I think that that should be done when the Company is flourishing, and we can consider that it is when you add £9,500 to the reserve fund and pay 5 per cent. dividend. While that is the case, and cordially endorsing your remarks as to the value and the efficiency of the experience we have gained, and the probable chances, therefore, of our competing very easily if competition is forced by construction companies, I think it would be a desirable thing to write off the capital account the small balance in reference to preliminary expenses. I leave my suggestion to your discretion, but I think it would be satisfactory to the shareholders to see that item no longer retained in the accounts.

Mr. NEWTON: Since I came into this room I had this letter put into my hand. Being a shareholder in some of the cable companies I received a copy of the prospectus of the new company, but I have not received this letter at my house. I think it should be circulated among all the shareholders of the existing telegraph companies.

The CHAIRMAN: Is that Mr. Weaver's letter?

Mr. NEWTON: Yes.

The CHAIRMAN: That has been done. As to the remarks of Mr. Jackson. He is perfectly right, but we have been writing off every year. The matter was discussed as to whether we might not write off a larger sum, but as we were placing a smaller sum to reserve fund, and since this last half year embraced a considerable portion of the 1s. tariff we thought it better not to be too severe on the shareholders. We were desirous of maintaining for their interest the 5 per cent. dividend, and as we have come back to the 2s. tariff we shall be able next half year to write off a larger sum. It was for the interest of the shareholders that we dealt with that item more leniently this half year. With regard to what Mr. Newton has said, there is no doubt that Mr. Weaver's letter is one which must have warned all thoughtful men about this new company. As far as I can hear, I think it has pretty well destroyed it. But destructive to their interests as Mr. Weaver's letter has been, I think the reply to it of the secretary of that Company has been more disastrous still. I think the weakness of the reply is so plain that any one who runs may read. As to fighting them, they say that "a burnt hand dreads the fire." I am afraid that the only way ever to get rid of them is by people simply losing a little money. It is as true as I am speaking to you now that people who put 20s. into this Company are very likely, if they get anything at all out of the investment, to get no more—they cannot possibly expect to get more out of it—than the companies now existing, and which have a large amount of goodwill and position. They cannot expect to stand higher, and all our stocks at the present time unfortunately are at 50 per cent. discount. I cannot conceive how men can pay 20s. in the pound for an article not half nor a quarter as valuable as an article that can be bought in the market for 10s. But still there are always inducements to bring up a crop of fools. As far as I can learn and believe there is very little chance of this new company ever getting beyond the paper prospectus which has been issued. He then put the motion in the usual manner, and declared it carried unanimously. Continuing, he moved "That Admiral R. C. Mayne, C.B., be, and he is hereby re-elected a director of this Company."

Mr. C. J. GUNTHER: I beg to second that resolution.

The CHAIRMAN put it, and declared it carried unanimously, and afterwards moved "That Charles Meara, Esq., be, and he is hereby re-elected a director of this Company."

Mr. FORD: I beg to second that.

The CHAIRMAN put the resolution, and declared it carried unanimously, adding: The next resolution is the election of auditors, and as that belongs to the shareholders, probably one of the gentlemen will propose it.

Mr. JACKSON: I have much pleasure in proposing the resolution put into my hands for the re-election of the auditors. The gentlemen mentioned have been the auditors of the Company from its inception, and I believe that the way they have looked after our accounts has always been satisfactory. I therefore move "That Messrs. John George Griffiths and Joseph Sawyer be, and the same are hereby re-elected auditors of this Company's accounts for the ensuing year."

Mr. NEWTON: I beg to second that, Mr. Chairman.

The CHAIRMAN put the motion, and declared it carried unanimously.

Mr. GRIFFITHS: Perhaps you will permit me to thank the meeting for the re-election of myself and colleague. It is very rarely I address the meeting, but on this occasion I might inform the shareholders, as I might have done previously, that the accounts are in excellent order, and looked after as well as can be, and that the auditors have a very pleasant duty to perform when they examine the securities of the Company.

Admiral MAYNE: I beg to thank you for my re-election.

Mr. MEARA: I also beg to thank you for my re-election.

The CHAIRMAN: That finishes the meeting, and I hope when we meet next half year we shall be able to give you a better account by the working of the 2s. tariff, and be able to report that, after all, those who are now trying to enter into competition will have thought better of it.

Mr. JACKSON: It is usual on these occasions to pass a vote of thanks to the chairman and directors, and I think it is desirable that we should do so now in face of this threatened competition, which I think has been pretty well exploded by our chairman, who has taken a great deal of trouble to go into figures and other details to satisfy us, with what our valued auditor has said that we have great reason to be satisfied. I think that the thanks of the meeting are due to the chairman.

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Mr. Hinton: I shall have great pleasure in seconding that.

The Chairman, in replying, said: Gentlemen—On behalf of my colleagues and myself I beg to thank you. I can only assure you that this is an enterprise—submarine telegraphy is an enterprise—that seems very attractive, but just as it is attractive it entails on us greater trouble and greater responsibility. It is a responsibility we feel, and an anxiety, having, I believe, perhaps even a higher object than simply securing dividends. We feel it is a security for the public, as well as to shareholders, that there should be a thoroughly efficient and beneficial system of telegraphy. That is the object we have in view, and I think we have fairly proved since we took up the management of this Direct Cable Company that such a system can be conducted in a way to give satisfaction alike to the shareholders and to the general public. As you know, it is not a large dividend that we pay, but we have been able to maintain that dividend throughout a trying and very troubled time, and I am still hopeful that we shall be able to continue it, and if kept free from competition for a little time I think even of the prospect of adding to it. In the meantime we have to husband our resources, and we shall take very good care, as far as attention and as far as watching closely the proceedings out of doors are concerned, that your interests will not be neglected; and we have the most hearty co-operation of our friend Mr. Weaver, who, with his great experience in those matters, is a very valuable and very important aid to us. We work in perfect harmony, and with the experience we can bring together, when I compare that experience with the prospectus which was lately put before the public, I can only say that if knowledge will lead to a successful issue we have the best of it.

The proceedings then terminated.

*** The above report appeared in our Special Edition of Saturday last, July 29th.

GLOBE TELEGRAPH AND TRUST COMPANY (LIMITED).

The ninth ordinary general meeting of this Company was held at the City Terminus Hotel, Cannon-street, on Thursday, 27th July, 1882, John Pender, Esq., M.P., in the chair.

The Secretary (Mr. William Payton) read the notice convening the meeting, and also the minutes of the eighth ordinary general meeting, which were confirmed.

The Chairman: Gentlemen—Before I make some general remarks on the subject of telegraphs generally, I will preface them by referring to a few details of the work which has been carried on during the last twelve months. I have first to call your attention to the fact that we have not been inactive during the past year, and that we have been enabled to make some tangible exchanges which we believe will be for the benefit of the Company. The proprietors should remember that these exchanges are made mainly in the interest of the ordinary shareholders. The wider the basis of our operations—the more we can exchange on proper terms so as to extend our range of securities—the greater the interest which the ordinary shareholder obtains. We have a very large holding in the German Union Telegraph and Trust Company, amounting to £108,000, which Company is the agent of the German Union Telegraph Company of Berlin. The Berlin Company found it necessary, in the interests of a growing traffic, and to avert competition, to lay a second cable from Emden to Valentia, so as to secure a direct cable communication for the German traffic to Ireland, without passing through this country as it did formerly. As you are aware, the French Company had a certain *amour propre*, or *esprit de corps*, in that direction, and the Germans seemed to entertain the same idea, and to meet the requirements of a growing traffic we thought it was better to countenance, as far as we possibly could, the Germans having their own direct line from Germany to New York. That cable has been made, and laid, but it involved the duplication of the capital of the Berlin Company, and they issued a Five-and-a-Half per Cent. Preference Share capital to meet the outlay. Your directors thought it well, having regard to the large holding of ordinary stock in that company, which is represented by their trust shares, to secure not only their rateable proportion of the Five-and-a-Half per Cent. Preference Shares of the German Company, but the further amount which was offered to them in exchange for preference and ordinary shares. The directors felt it essential to cover the risk of the German Union Trust Shares by acquiring those preference shares, which are, no doubt, a good security, because the German Union Company of Berlin paid 10 per cent. per annum for the year 1880, and $8\frac{2}{3}$ per cent. for the year 1881, and the prospects are now much better than they have been. The purchase, however, being a large one, involving something like £140,000, the available cash balance of this Company, and the proceeds resulting from the sale of the 4,647 Bonus Trust Certificates, was applied to this purchase, and we also had to borrow £18,000, which is the extent now of our liability on this purchase. You will observe that we have been able to acquire these preference shares at a price which will give us £5 5s. per cent. per annum, or say 6 per cent. for our preference shares, and $4\frac{1}{2}$ per cent. for our ordinary shares. We have acquired a small parcel of 150 German Union Telegraph Trust Shares. We have exchanged also 500 Indo-European shares for our shares on favourable terms, and also 1,000 Eastern Telegraph shares. We look upon these shares as a very valuable property. For the years 1880 and 1881 we were enabled to declare dividends on the ordinary shares of $4\frac{1}{2}$ per cent. per annum, and your board regret to have to show a falling off from this rate of interest. It is a small falling off, but it is a falling off that we expect will be very soon recovered [hear, hear]. This is attributable, however, to one cause only, and that is the competition in the Atlantic. In the financial year ending July, 1881, we received $3\frac{1}{4}$ per cent. from the Anglo-American Company, making the sum of £36,400. In the past financial year ending July, 1882, we only received $2\frac{3}{4}$ per cent, or £30,800, a difference of £5,600, the result of the competition. This is the main reason why our dividend has diminished. The 2s. tariff now in force is bringing in such an amount as to make us hope that the next dividend of the Anglo-American Company will be such as will enable us to receive the dividend that we paid last year. With regard to our expenditure there is very little difference as against the last year, and we give full details of our very modest outgoings. When we make exchanges of shares in the ordinary course of our business, we have from time to time to apply to the Committee of the Stock Exchange for an extension of the quotation of the Company's shares on the Stock Exchange list, so as to embrace the number of shares issued, and to keep our quotation and issue of shares in perfect order. That is so now. An item of expense is postage and dividend stamps; but the number of shareholders of the Company is still on the increase, and I presume we may take it as an evidence of the popularity of the security which the Globe Company offers that, while last year they had reached the large number of 5,800, they to-day number 6,250. Since I last met you here our friend and colleague, the Right Hon. W. N. Massey, has passed away, and in him we have lost a man of very good sound sense. He had been associated with the Globe Company from its commencement, and his death is a loss which we all deeply regret. We have appointed in his place at the board Mr. Henry Daniel Gooch, son of Sir Daniel Gooch, whose name is honourably associated with submarine telegraphy, and who holds a very large interest in the Company. Mr. Gooch has also had some experience in connection with telegraph companies, and, therefore, we have in him a young life, and a valuable acquisition to the board. Mr. Newmarch, who was one of our auditors, has also passed away. Mr. Newmarch's reputation was world-wide, and every one who saw his name was satisfied that the work with which he had anything to do would be conducted with the highest sense of honour. We have appointed in the place of Mr. Newmarch, Mr. Griffiths, or rather, I should say, the shareholders at the last meeting were unanimous in their appointment of Mr. Griffiths, barrister-at-law, in the place of Mr. Newmarch. So far as I have had an opportunity of observing him, Mr. Griffiths has been very careful indeed in seeing that the securities of the Company were in proper order. Now, gentlemen, I have to make a few general remarks. In the first place I may refer to the cable competition in the Atlantic. I have no doubt you have seen in the newspaper the prospectus of the company that was launched last Saturday, and also the reply of the managing director, or rather the criticism of the managing director of the Anglo-American Company. That reply is so complete that I need scarcely add one word to it. The only thing I may say is that it does astonish me that in a great commercial city like this such a prospectus should have been issued at all. The men who have prepared it, and I am afraid many of the honourable names who are associated with it, have not in the slightest degree a knowledge of the subject to the prospectus of which they have attached their names. I can only say that if that company is floated, of which I have very great doubt, it will be almost impossible for them to realise what they have put forward in the prospectus. Therefore a very grave responsibility rests on those who have issued the prospectus, a responsibility so great that I am perfectly satisfied that the result will be, when many of those who are associated with it begin to realise the responsibility, that there is very little chance of that company proceeding beyond the paper on which that statement has been made. However, that is a matter which rests entirely with those gentlemen. There is just one point which I may mention, as showing how extraordinary the statement put forward in that prospectus is. Notwithstanding the eight cables which we now have in the Atlantic belonging to the combined cable companies, capable, when they are in good working order, of doing the work of sixteen cables, this new company assumes in their prospectus and their calculations, that they are to do not only all the traffic that those eight companies do, but something more than all the traffic which is obtained in the Atlantic at the present moment. I think you will see at a glance that the old companies must be in a very extraordinary state if they are to stand still and see their business pass away into the hands of this new company. With the cables that are put down it will be simply impossible for them to do their work. They assume that they can do 25 words a minute; Sir James Anderson, who has great experience of what the best manipulators can do at the present moment, informs me that 16 words a minute is uncommonly good work. Therefore, the whole of the statements throughout which are contained in the prospectus, I am sorry to say, show the greatest possible ignorance on the part of those who concocted it.

Sir James Anderson: They will not do 10 words a minute.

The Chairman: Sir James Anderson, as a practical worker of the system, says that they will not do 10 words a minute.

Sir James Anderson: I mean not 10 money-paying words.

The Chairman: Therefore, so far as I know, and looking carefully into the figures, the chances are that instead of showing the profit which they announce they will make, the loss will be nearer £50,000, even taking their own figures so far as expenditure goes. There is another cable, which is projected by Mr. Garrett, of the Baltimore and Ohio Company. I am making these remarks, because, as you know, your dividends depend on the good dividends coming from the existing companies. Mr. Garrett's scheme is to utilise as far as possible the telegraphs along a very extended and very important system of railway in America, namely, the Baltimore and Ohio line. The Baltimore and Ohio Company have not themselves obtained an Act of Parliament in Washington for laying the new line, but a number of people connected with that system have obtained this Act of Parliament. My own impression is that the men connected with this Company are shrewd men, but they are not likely to get any money in America if they cannot get it in England. They are quite justified in making this addition to their system, but my own impression is that while our telegraph lines generally are at 50 per cent. discount, that the money is not likely to be realised in England. I think that there is a probability that even Mr. Garrett, shrewd man as he is, will reconsider the question before he induces his friends to go into this large expenditure. I think that now, with the working powers of which I have just told you, namely, sixteen cables in the Atlantic with the duplex system, it is possible to provide Mr. Garrett's system with as much cable power as he requires for his operations in America, and, therefore, as I have always been a man of peace with regard to submarine telegraphy, I have always thought that it was better that there should be combination rather than fighting with one another, because in the long run compromises have to be made. I am hoping that before I have the pleasure of seing you again some means may be arrived at whereby we may utilize Mr. Garrett's system by materially improving our own. The next system that I must refer to is that of the Eastern system of telegraphy and the Eastern Extension. I daresay you are all aware of what is going on in Egypt at the present moment. Probably no Company has been more before the public, and more prominently engaged in doing good and useful work for the community at large than that Company. Had it not been for the arrangements made by the Eastern Telegraph Company, we might, I believe, have been without any communica-

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tion with Egypt to day. I am sorry to say that we have not to thank the Government very much for providing us with anything. We have provided the means for the Government of securing rapid and perhaps the best working system of telegraphy between England and Europe at the present moment. We have done that entirely by the exercise of forethought by bringing a ship at a considerable expense from the Red Sea to Alexandria, and establishing on board that ship our working system, so as to keep the public informed of all that is going on there, so that every hour of the day when the newspapers print a fresh edition, that fresh edition springs entirely from the telegraphic communication which has been established by the Eastern Telegraph Company [hear, hear]. At the present moment there is an interruption to our Eastern system in crossing the Isthmus of Suez. I am sorry that that interruption should exist. If we had had our own way it would not have existed. We feel that England should not be backward in retaining that telegraphic communication which is so valuable at the present moment, and I hope we shall be able to show the Government that we, at all events, do not undervalue the importance of telegraphic communication with our Indian Empire. If there were an interruption of even one week I should dread the consequences [hear, hear]. There is another system working to India, and that is the Indo-European system. That system is a valuable system in this way. We are, I may tell you, partners with that system, and, therefore, at the present moment we are not losers to any appreciable extent by the interruptions of our system; but I think it is not desirable that England and India should be entirely dependent on this one line which passes at the present moment through Germany, Russia, Prussia, and the Persian Gulf. Only yesterday one cable in the Persian Gulf was interrupted, another might be interrupted to-morrow. Consequently, an alternative line is desirable, which alternative line we have when we are in full working order. We are, as I have told you, working in perfect order with that system, in fact, it forms an arm of the general system. Therefore, at the present time, while I am pressing rather hard upon the Government, there is still a communication, but an uncertain communication, between India and England, but I hope that we shall be able before long to connect again with India by means of the Suez canal. As you are aware, Gentlemen, our revenue entirely results from the efficient working of these different systems of telegraphy. The trade of the the world, I may say, is now carried on almost entirely by telegraphy. The large trade that we are doing with India and our colonies, or, I believe, nine-tenths of the whole of it, originates in telegraphic messages, although it is documented afterwards, but the origin of these operations springs from the telegram. Therefore, any interruption, or any uneasiness in India, or any other part of the world, of the great centres of commerce, affect us very materially indeed. It is, therefore, of the greatest importance that all panic should be prevented as far as possible, and when we are in a position to receive from hour to hour communications from our colonies, from India, and different parts of the world, that everything is going on smoothly and well, the public mind is at rest, but if there was any permanent interruption to our telegraphic system the trade operations would be prevented, and the public mind generally in both countries would become excited, and the result would be a serious loss indeed. The board of the Globe Company, as the advisers of other companies, and as being interested in all the other companies, have made it their special business to see the Government almost daily upon the subject, and to urge upon them the importance of having this communication re-established between India and Europe [applause]. With these remarks, Gentlemen, I beg to move—"That the report and accounts of the directors for the year ending July 18, 1882, submitted to this meeting, be, and they are hereby received and adopted, and that the following dividends be now declared, payable this day, viz., 3s. per share on the preference shares, making with previous quarterly payments a total dividend of 6 per cent. for the year ending July 18, 1882, and 2s. 9d. per share on the ordinary shares, making with previous quarterly distributions a total dividend of 4½ per cent. for the year ending the same date, both free from income tax."

The MARQUIS of TWEEDDALE: I beg to second that motion.

The CHAIRMAN: The resolution having been moved and seconded, if any gentleman has any question to ask before I put the motion to the meeting I shall be very glad to answer it.

There being no response, the motion was put and carried unanimously.

The CHAIRMAN: The next resolution which I have the honour of submitting to you is, "That the Marquis of Tweeddale be, and he is hereby, re-elected a director of this Company."

Sir JAMES ANDERSON: I have much pleasure in seconding the motion.

The motion was put and carried unanimously.

The MARQUIS of TWEEDDALE: Gentlemen, I beg to thank you very much for the honour you have done me in re-electing me as a director of this Company.

The CHAIRMAN: Gentlemen, the next resolution is, "That Mr. H. D. Gooch be, and he hereby is, re-elected a director of this Company."

Mr. W. FORD: I have much pleasure in seconding the motion.

The motion was put and carried unanimously.

Mr. H. D. GOOCH: I beg to thank you, Gentlemen, for the honour you have done me in re-electing me a director of this Company, and I beg to assure you that my best exertions will be used in furthering your interests.

The CHAIRMAN: Gentlemen, the next resolution is with regard to the election of auditors. As that rests with the shareholders I beg that a shareholder will move the resolution.

Dr. DRAGE: I beg to move, "That Mr. J. G. Griffiths, F.C.A., be, and he is hereby, re-elected auditor of this Company for the current year with a remuneration of 30gs."

The motion having been seconded, was put and carried unanimously.

Mr. CROFT: I beg to move, "That Mr. W. Griffith, B.A., be, and he is hereby, re-elected an auditor of this Company for the current year with a remuneration of 30gs."

Mr. SCOTT: I beg to second the motion.

The motion was put and carried unanimously.

Mr. GRIFFITH: Gentlemen, I have to thank you for this renewed mark of your confidence in re-electing me as one of your auditors. Our chairman has, with very great eloquence, referred to the loss which the Company has sustained in the death of that eminent member of the board, Mr. Massey; therefore, it is unnecessary for me to add anything to what he has said. Mr. Newmarch, as you are also probably aware, has also passed away. There was no more eminent authority than Mr. Newmarch in the money world. You are, probably, aware that he was a member of a most eminent firm. He served the Company both faithfully and well from its commencement down to the time of his death. For myself, in following the steps of so great a man, I think I may say that I have endeavoured to do my duty on all occasions. I thank Mr. Pender for the manner in which he has spoken of the way in which I have performed my duty. I may say that the securities have been thoroughly inspected, and the seal which has been placed upon them by Mr. Newmarch did not prevent us from opening them and examining them. I may also say that the books, which are exceedingly well kept, have been thoroughly examined, every transaction being analysed and proved to be of a good and satisfactory character. Again I thank you for your confidence, and I beg to assure you that no effort shall be spared on my part in promoting the interests of your Company in the time to come [applause].

The CHAIRMAN: Gentlemen, that finishes the business of the meeting.

Mr. GARDINER: Gentlemen, I beg to move a vote of thanks to the chairman and the board of directors for the care and attention which they have bestowed upon the affairs of this Company.

The motion having been seconded, was put and carried with acclamation.

The CHAIRMAN: Gentlemen, we are much obliged to you for your continued vote of confidence. It is my earnest desire, and that of my colleagues, to watch carefully over your interests, and to see that all the other companies are so conducting their affairs as to secure good dividends for themselves, and, consequently, good dividends for you.

⁂ The above report appeared in our Special Edition of Saturday last, July 29th.

THE SUBMARINE TELEGRAPH COMPANY.

The half-yearly general meeting of the above Company was held on the 1st inst. at the offices Throgmorton-avenue, Sir James Carmichael, Bart., in the chair.

The SECRETARY (Mr. S. M. Clare) read the notice convening the meeting, and the report of the directors (for the half year ended June 30 last) was taken as read. It stated *inter alia* that there was a balance of profit in favour of this Company of £38,516, which enabled them, after adding 10 per cent. of the gross receipts to the reserve fund, to recommend a dividend at the rate of 19 per cent. per annum, and to carry over £123. The cost of repairs to cables during the half year had been less than in the corresponding period of 1881 by £1,338. All the cables belonging to and worked by the Company were in good order. In accordance with the resolution passed at the meeting of the proprietors in February last they had contributed on behalf of this Company and the Société Carmichael et Cie. £200 to the fund being raised for the benefit of Mr. Jacob Brett, and charged this sum and a further amount of £740, which had been granted to the widows of three clerks, lately deceased, against the revenue of the half year.

The CHAIRMAN said: Gentlemen—I have very often had the pleasure of moving the adoption of the report and accounts of this Company, but I do not know that I ever did so with a feeling of such great difficulty of having anything to say to you. I have not the smallest peg on which to hang a speech. I trust, however, that my few remarks will be regarded as very satisfactory. Looking at the report, and having had the reports for each half year, you will have seen that the repairs to our cables are lighter than usual—in fact, we have been very fortunate in the last half year as to the repair of our cables. On the other hand, by looking at the item in the amount of salaries there is an increase of about £1,790 over the corresponding half year of 1881. Now, this chiefly arises from the very large additional number of messages carried in that period, amounting to no less than 100,000 messages in excess of the number transmitted at the corresponding period of 1881. This increase has necessitated our establishing eight additional circuits to the continent, and we have had to employ about fourteen additional clerks. That will pretty well account for the increase you see in the amount of the salaries. I think it may be satisfactory to you to know that on the 19th of June we transmitted the largest number of messages over our wires that has ever been sent in one day, namely, 10,867; and during that week 58,000 telegrams, containing 751,059 words were forwarded and received. That is the best week we have ever had in the history of the Company, and I congratulate you. I only trust that the business will go on progressing as it has done since the beginning of the half year. I am quite sure that you will all regret with the board the death of our valued old colleague, Mr. Samuel Gurney, who, with the exception of myself, was the oldest director of the Company, having been with us since 1858. I really have nothing else to detain you with. I have told you a very short story, but I hope that it has been a satisfactory one. I now beg to move the adoption of the report and accounts.

Mr. FORDE (a shareholder), in seconding the motion, congratulated them on having all the cables in good order, and expressed a hope that they would remain so.

The CHAIRMAN: Has any gentleman any question to ask? I shall be most happy to answer them. No one rising to address the meeting, he put the resolution, which was carried unanimously. Continuing, he moved—That, in accordance with the recommendation of the committee of directors, a dividend for the half year ended 30th June, 1882, at the rate of 19 per cent. per annum, less income-tax, on the capital of the Company, be declared and paid on and after the 1st September next.

Mr. CASTLE SMITH seconded the resolution, which was carried unanimously.

On the motion of Mr. FORDE, seconded by Mr. TOWNE, the retiring directors, Sir J. Carmichael, Bart., and the Hon. Ashley Ponsonby, were re-elected to their seats at the board.

The CHAIRMAN: I beg to thank you for your renewed confidence. I hope to meet you next half year with the same satisfactory report.

Mr. CASTLE SMITH next proposed the re-election of the auditors, Messrs. G. C. Capper and William R. Cole and Sir Thomas Dakin. He thought that the state of the accounts testified sufficiently in favour of those gentlemen to justify their re-election.

Mr. HARDY seconded the resolution, and it was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. G. C. CAPPER, Mr. H. R. BRAND, M.P., was elected to the seat at the board rendered vacant by the death of Mr. Gurney.

Mr. FORDE then moved a vote of thanks to the chairman and directors.

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He congratulated them on being able to put before the proprietors such a very satisfactory report and clear statement of accounts.

Mr. Towne seconded the motion, which was carried unanimously.

The Chairman having returned thanks on behalf of his colleagues and himself, the proceedings terminated.

EASTERN TELEGRAPH COMPANY (LIMITED).

An extraordinary general meeting of the members of the Eastern Telegraph Company (Limited) was held at the offices, No. 66, Old Broad-street, on the 3rd instant, "for the purpose of confirming the special resolution passed at the extraordinary general meeting held on the 13th July, 1882, authorising the creation and issue of mortgage debenture stock of the Company to an amount not exceeding one-third of the paid-up share capital for the time being, for redemption of debentures and other purposes, and regulating the transfer thereof and the powers of the Company in relation to purchasing and dealing with the same." Mr. Pender, M.P., presided.

The Secretary (Mr. George Draper) having read the notice convening the meeting,

The Chairman said: Gentlemen, as you are aware, this is a special meeting for a special purpose, and that is to move the confirmation of the resolution which was passed at the last general meeting of the Company. I shall, therefore, call on the secretary to read that resolution.

The Secretary read the resolution, as follows:—

(A). That the board of directors be, and are hereby authorised from time to time to create and issue mortgage debenture stock of the Company to an amount not exceeding one-third of the share capital of the Company for the time being issued and paid up, upon the terms that the aggregate amount of the said stock for the time being in issue, and the interest thereon, shall rank *pari passu* as a first charge on the undertaking and revenue of the Company, the stock to be issued at such times, in such amounts, and on such terms and conditions as the board shall from time to time determine, for the purpose of redeeming by exchange or otherwise the outstanding debentures of the Company, and any other purpose to which capital of the Company may be lawfully applicable.

(B) That the board be, and are hereby authorised to make such provision as they think fit for the registration and transfer of mortgage debenture stock, and for the delivery of certificates thereof, and for the issue of stock warrants to bearer transferable by delivery, and of interest coupons attached to such certificates and warrants or otherwise, and for the conversion of warrants to bearer into registered stock, and of registered stock into warrants to bearer, and generally as to the form and incidents of all documents relating to the said stock, but so that no such provision be inconsistent with paragraph A of this resolution.

(C) That the board be, and are hereby authorised from time to time to purchase in the market and hold and deal with any amounts of such mortgage debenture stock for the purposes of any reserve fund or investment of the Company, and, with the sanction of a general meeting, to apply other moneys of the Company to the purchase in the market of any such stock for cancellation, and, with the like sanction, afterwards to re-issue mortgage debenture stock in lieu of all or any of the said stock so cancelled, provided always that the amount of mortgage debenture stock issued and outstanding shall never exceed the limit prescribed by paragraph A of this resolution.

The Chairman then moved the confirmation of the resolution.

The Marquis of Tweeddale seconded the motion.

The Chairman put the resolution in the usual manner, and having declared it carried unanimously, said: That is the business of the day, and we have now to act on the resolution, and I hope we shall turn it to good account.

Mr. Griffith: It may be formal, perhaps, but I wish to propose a vote of thanks to the chairman and directors. The business is so simple and formal that it is scarcely necessary to move it, but it has been suggested by another gentleman, who will second it.

A Shareholder having seconded the motion it was carried unanimously.

The Chairman: On behalf of my colleagues and myself I am very much obliged to you for the compliment you have paid us.

The meeting then separated.

RAILWAY AND ELECTRIC APPLIANCES COMPANY (LIMITED).

The statutory general meeting of the above Company was held on the 28th ult., at the Cannon-street Hotel, under the presidency of Mr. William Alexander Smith (of Glasgow) in the unavoidable absence of the Duke of Manchester, the chairman of the Company.

The Secretary (Mr. William Skinner) having read the notice convening the meeting,

The Chairman said: You are probably aware that this is what is called the statutory meeting—that is, a meeting that must be called within four months of the registration of the Company, in conformity with the Act of Parliament. Of course you are probably aware that although our Company was registered four months ago, we really have not been in possession of our property, nor have we executed the transfer of the shares until within the last six or eight weeks. The directors, therefore, have really only to report upon what has been done during a very limited period. I have to mention that two of our directors, Sir George Prescott and Lieut.-Colonel Elliot, have lately visited Glasgow, and inspected the works acquired by the Company. You are aware that the works taken over by this Company were situated in two different parts of the city of Glasgow. The principal work, which has become the property of the Company, was situated two miles to the south side of the city, and the other, in which we made our telephonic apparatus and smaller electrical appliances, was situated in the city, thus necessitating a very large waste of time in the transfer of various goods from one works to the other. The result of this was that it has been deemed expedient that the works should be entirely concentrated under one roof, thereby effecting a very considerable saving. You will be glad to learn that we have ample room for sufficient extension at the works which have been acquired at Polmadie, and plans have been already drawn, and approved of by the directors, whereby in a few months the object we now desire will be attained. In the meantime we have devoted our energies principally to consolidating the work we have in hand, getting up patents for work we know we shall get, and generally organising work, which we have no doubt will lead us to the results we all wish for—a profitable agency for our money. There is one other point that I should like to allude to—the electrical apparatus. Some time ago we received authority from the commission of engineers appointed to inquire into the electric light to send our appliances to Chatham. This was done the week before last, and I can tell you that the results have not only come up to our expectations but have actually exceeded them, and there cannot be in my mind any doubt that very good results will come from that trial. You are aware that in dealing with the Government the Government must act very cautiously. They have beside them all the various appliances so as to enable them to test, but I have good reason for stating that I know that the opinion of those in immediate charge of those operations is highly favourable to the lamps and dynamos manufactured by this Company. As to the Maxim lamp, the rights of which we have acquired for Scotland, I may tell you that my own personal experience of that lamp is satisfactory to a degree. It is quite true that the Maxim lamp requires more power to work it, but, on the other hand, it has advantages which I think will show it to be, for practical purposes, one of the best, if not the best incandescent lamp ever brought before the public. It is not so liable to break as any of the other lamps. I do not speak merely from experimental trials as to the Maxim lamp. Three seasons ago the Glasgow Art Union asked us to fit up their gallery with the electric light, and after a series of experiments lasting over several months, trying the Swan and a variety of other lamps, we finally fixed on the Maxim as being the best for that purpose. You will be glad to know that for the last three seasons the Art Gallery has been lighted by the Maxim lamp, to the perfect satisfaction of every one, both the exhibitors and those wanting to see the pictures. The fact is, we have been able in the large hall to replace 264 gas jets by 60 Maxim lamps, with the result that we not only get a better light, but the atmosphere remains perfectly cool, even when the room is crowded. There is also another advantage which must not be lost sight of—that colours come out exactly the same by the electric light as by daylight, thus demonstrating one of the advantages always claimed for the electric light—that it gives a true sun light for anything that may be exhibited or seen by it. Now, the importance of this fact is almost sufficient, to those who really have thought the matter out, to convince any one that, be it this or next year, the electric light must take the place of gas. I care not how much you may improve the burners—and there have been vast strides in that direction—but the fact remains that a light obtained by the consumption of gas does change any colour entirely, and prevents people from distinguishing various grades and different shades. That is not where it ends. Gas consumes, as you are aware, the very life-giving property of air, oxygen. It robs the air of the very life-giving property we breathe in it; and you would hardly believe that a small gas burner—a No. 4 Bray—consumes as much oxygen as five grown-up men. You will thus be able to calculate what vitiation goes on with ten or a dozen burners alight in your drawing room at one time. My opinion of the lamp we have secured is that it is unmistakably one of the best, if not the best, incandescent lamp ever brought before the public, and with a little time, patience, and energy, I look to there being a vast field for the development of this incandescent light, and especially among ships. I have authority for saying this from one of the largest shipowners in the world—Mr. John Burns, of the Cunard—that he did not expect he would build or fit out another Cunarder that was not fitted with the electric light. That is only one case. When we are in a good position to execute these orders as we wish, in a way that no fault can be found with them, we shall obtain a very large share of any orders Mr. Burns, or any other Glasgow shipbuilder, may have to give. I now come to one of the most important assets the Company possesses—the Williams railway patents. These inventions, as you are aware, are American. They to a certain extent change the system of working of railways in this country. They do away entirely with crossings; they avoid all brakes on continuous main lines of railway; they prevent the possibility of such an accident as recently happened where the tyre of a wheel took the wrong side of the point; and they also enable you to put down a crossing at almost any part of a line you like without in any way interfering with the working of the main line. That is not the only advantage they have. The present system of crossings takes a gang of men something like eight hours to fit in. That is if there was an accident, or if anything went wrong on a crossing, if discovered before an accident took place, it takes eight hours to put in a new one, during which the main line traffic is interrupted. By the Williams invention, however, a crossing may be fitted in in from twenty minutes to half an hour without any interruption to the main line traffic. You may naturally ask, why has this system not been adopted more largely? I reply to that, for the same reason that it took something like four or five years before Sir Henry Bessemer got his steel rails adopted. I reply to it further, that one of the most powerful of our railway companies—the London and North Western—has not yet adopted the Westinghouse brake, which has been so generally admitted to be the best. Wherever the Williams invention has been adopted it has given great satisfaction, and Major Marinden, the Board of Trade inspector, has investigated it, and reported very favourably on it. It has been in use for ten years on one line. It has also been laid and carefully tested by the Great Northern Company, near King's Cross. It is quite true that it has been put in a siding by them, because they had fears for the main line traffic, but the result of the trial so far has been satisfactory in the very highest degree. I have, therefore, very little doubt in my own mind that, with energy and with pushing the matter, and by not being afraid to spend a certain sum of money in laying down experimental cross-overs, and demonstrating the real utility of these inventions, before many years are over our heads we shall find that it will revolutionise the railway system, and the Company will, probably, have one of the finest properties ever brought out in this country. With these remarks I would ask you to approve of the general acts of the directors up to this time. I would add that if any shareholder has any question to ask, I will do my best to reply to him in as satisfactory a way as possible.

Mr. J. B. Hamilton referred to the amount of subscriptions to the

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capital being less than was invited by the prospectus. The vendors were to have one-third of the profits, and the capital being £180,000 the vendors would get 80-180th parts instead of 80-250th parts. He would, therefore, point out to the shareholders, if it was not the proper thing for them to insist, on the division of profits, of the vendor making an abatement to the extent of the difference. On the face of the prospectus it was never contemplated that the vendors should get more than 95-250th parts. With the present limited capital they would get more.

The CHAIRMAN, in replying, said he was very much indebted to Mr. Hamilton for bringing this point out. Mr. Hamilton had very clear ideas of what was right and wrong, and what was fair and what was not fair. What Mr. Hamilton had said was quite true as matters now stood. Though his figures were not correct his idea was correct, but the shareholders must not forget this—that the directors had the power, if they chose, and if the development of the business necessitated it, to issue up to £500,000, which would then only give the vendors one-sixth instead of one-third of the profits. Any shareholder who chose could increase his interest, as the capital had not been fully subscribed. They could not legally do what Mr. Hamilton had suggested.

Mr. HAMILTON replied that he had only made the suggestion to the shareholders, leaving them to take any action on it. He would not move any resolution on the subject.

The CHAIRMAN thanked Mr. Hamilton, and having announced that the meeting was at an end, expressed a hope that at the next meeting they would have a statement to place before them which would please them.

A vote of thanks to the chairman terminated the proceedings.

THE UNITED TELEPHONE COMPANY (LIMITED).

The second annual ordinary general meeting of this Company was held at the City Terminus Hotel, Cannon-street, on the 1st instant. The notice convening the meeting stated that it was "for the purpose of receiving, and if thought desirable, of adopting the report of the directors and the accounts for the year ending April 30th, 1882; also for the purpose of confirming two agreements—the one made with Mr. Arthur Dudgeon, of 32, Merrion-square, Dublin, and the other made with Mr. George Hunter Robertson, of 33, Brown's-buildings, Liverpool. The above agreements respectively are for granting, in the first case, to a company formed under the name of 'The Telephone Company of Ireland (Limited),' and in the second case, to a company intended to be formed under the name of 'The Western Counties and South Wales Telephone Company (Limited),' exclusive licenses for use of the Company's patents in certain districts, partly in consideration of fully-paid shares in such respective companies, and partly in consideration of royalties; and in connection with such licenses to sell for fully-paid shares and cash any business now carried on by the Company within the districts comprised in such licenses respectively, and any property used in such business."

The chair was taken by Mr. James Brand.

The SECRETARY (Mr. Blaikie) having read the notice convening the meeting, the report of the directors and the accounts for the year ended the 30th April last were taken as read. The report stated, as regarded capital expenditure, that up to 30th April, 1882, £55,966 had been expended upon the works in connection with the London and provincial exchanges and the stock of instruments, being £21,739 more than the outlay shown in the last balance-sheet. The revenue account showed that the receipts of the Company from all sources properly attributable to the year had been £42,624 as against £20,644 in the preceding year, or an increase of £21,980. The working expenses of the year had been £21,050 as against £20,273 for the preceding year, or an increase of £776. The balance of net revenue was £21,945, and the directors recommended the distribution of a dividend of 5 per cent. for the year, leaving a balance of £1,945 to be carried forward. Considering that the public were only beginning to realise the great convenience and saving of time and expense consequent upon the use of the Telephonic Exchange system, and having regard to the practical difficulty attending the erection of the necessary machinery for the efficient performance of the service, the board hoped that these results would be appreciated by the proprietors.

The CHAIRMAN: It will be for me now to make a few remarks, and I will make them as brief as possible, on the report and accounts. I think we have made them so clear that they will require very little explanation from me, and will not leave a great deal for me to say. I think I may fairly congratulate you on the progress that we have made, and, considering the large additions made to our systems and the amount of work we have done, I do not think our capital expenditure has been excessive. We may, I think, at any rate, congratulate ourselves that the work for which you have paid is good work, for notwithstanding the sinister prognostications which I dare say you all remember were made about a year and a half ago, when we were in such trouble, by some of those connected with us in the early part of our undertaking, who said that not only was our work bad, but that it would be a source of fatal mischief to the populace, and that the chairman and the directors would in consequence run the risk of being indicted for manslaughter, I am glad to say that we have not had a single accident to report from our wires, and that our works have stood the test of tremendous and very heavy storms and strong winds—perhaps the most tremendous that ever happened in the lifetime of any of us. I think that is a subject of congratulation. You will notice that our revenue has increased up to the 30th of April last by nearly double, and since then we have had a further very large increase, and fresh subscribers are coming in very fast. Our working expenses, no doubt, are heavy, but they show a very small increase on last year, and notwithstanding the large increase of business our indefatigable managing director (Mr. Morgan) uses every effort to keep them down; and no doubt as we get more knowledge of the working of our peculiar business, and avail ourselves, as we do, of every new invention which we find out to be an improvement, we shall reduce the expenditure, and we fully believe that its proportion to our income will become less and less every year. As to our modest dividend, I can say that we have earned it. We could, with your permission, have followed the course we did last year, and realised part of our shares in one of our subsidiary companies, so as to make a good division in the shape of bonus, but we have considered that the course we are pursuing is the best for all our interests. We divide what we fairly earn, and for the present we leave our shares to stand not only as a means of earning and helping to earn our dividend, but as a substantial reserve fund in addition to the large sum we wrote off last year against depreciation of plant, renewals, and all other troubles that our peculiar business is heir to. I now come to our relations with the Post Office, which is a most important part of our business, and the satisfactory carrying out of it. I think our report is pretty clear on that point. We are using every effort to satisfy the Postmaster-General as well as the public that we are able and willing to perform the service and duties we have undertaken. I believe that we have given him so far such satisfaction that he has no need to exercise the right reserved to him to step in and do our work himself. We intend to make our work much more perfect, and perhaps some of you may say that that is very necessary; but we have great difficulties to contend with, and if you knew them you would be lenient with us. If any subscriber is here and has any complaints to make he may write to Mr. Morgan, who will see to them, or he may write to me, and I will engage to see to them personally, as I have done. We are now trying to make a great extension of our work, and we hope very soon to have it put before all the suburbs, and extend its working to all sea side places. I had hoped almost by now that Brighton would have been put in communication with London, but I do not think it will be very long before that takes place. We are getting on very well with subscribers in Brighton, and we hope soon to have telephonic communication between there and London, so as to enable men of business to carry on their work there as if they were in their counting houses. All this, however, involves an enormous amount of time and labour, especially in the matter of way-leaves—a matter which is very difficult, and which, when we use railways, we can scarcely overcome at all without the cordial co-operation of the postal authorities. You will, doubtless, have seen Mr. Fawcett's statement that he did not consider he could continue to grant anything in the shape of a monopoly to any one telephone company. This monopoly—the monopoly we enjoy, if it can be called a monopoly, is one of the very smallest kind, as the Postmaster-General reserved to himself the right to conduct our business himself if we did not carry it out efficiently. I think every one will allow that this takes away the sting of the word "monopoly" from the rights we have, and I think it is more a matter of carrying out his free trade principles, or something of that kind, that induced him to alter his previous decision, which I venture to think the just decision. This Company being the progenitors of the telephone work, and telephone business being a very difficult one to carry out, I think he made a just decision formerly in confining the work to us. As to this matter of one company alone being able to carry out telephone work, I have to say this, and I am bound to say this, as I believe it to be entirely true—that it cannot be satisfactorily carried out in one town or district by more than one system; for, independently of the trouble and difficulty which would be created by rival candidates for subscribers and way-leaves, the benefits of the telephone would be destroyed by the fact that subscribers by one system would be cut off from the subscribers by another. We have, again, to consider this fact—that we find that since the telephone was invented, wherever it was attempted, in America or Europe, to introduce two or more systems in one place, dire confusion has followed, and a fusion of systems and the use of identical instruments have been compulsory. It has, however, been thought fit to announce that licenses will be granted to certain persons, but they must have proper instruments to carry them out. I think that is rather a doubtful enterprise on their part. They must then get subscribers, and then will commence all the troubles of their undertaking—troubles which we have undergone and are undergoing, but which we, to a certain extent, have generally gone through. We are not afraid of competition, and we shall continue as we have done all along to develop our very great and interesting enterprise. As to our patents, which one way and another have cost us so much anxiety and money, we have at last, I hope and think, put them on a satisfactory basis. We have from time to time kept you fully informed of the law suits in which we were engaged. In Scotland we have been entirely successful, and Lord McLaren upheld the validity of our patents to the fullest extent. In this country the technical objection that Mr. Justice Fry made concerning our Edison patent was overcome by a disclaimer on Saturday last. I will read you what our solicitors, Messrs. Waterhouse and Winterbottom, say on this subject. This letter was written to me last night by them:—"Dear Sir: You will like to be able to report to the shareholders at the annual meeting to-morrow the present position of matters with regard to the Company's patents. We may assume that they are acquainted with the contents of the circular letter of the 24th of May last (as you remember we sent one to every shareholder), in which the successful issue of the process in Scotland was reported, and also of the result of the more recent litigation in this country before Mr. Justice Fry, resulting in a judgment for the Company on the Bell patent, but in an adverse decision on the Edison patent on a technical objection relating to the phonograph. In substance, his lordship's decision amounted to this, that Mr. Edison's claim for what is known as the carbon transmitter was a good claim, and covered the instruments used by the defendants, but that Mr. Edison having included in the same patent a claim for the phonograph, which claim could not be sustained in consequence of insufficient description of the invention in the provisional specification, the whole patent was vitiated. As the result of a very careful consideration of the question by counsel immediately after the decision of Mr. Justice Fry, it was thought well to apply at once for leave to disclaim the phonograph without waiting for the decision of the Court of Appeal on the question whether Mr. Justice Fry was right in his decision on this point or no. The case could not have been brought before the Court of Appeal till the end of the year, and although counsel advised that the appeal would probably result in the Company's favour, this was necessarily only an opinion, while a disclaimer would be decided more promptly, and, if obtained, would dispose once and for all of the objection. The necessary application for a disclaimer was accordingly made, and we are glad to be able to report that the Attorney-General, on Saturday last, after carefully considering the whole case, granted the leave asked, and the necessary disclaimer would be forthwith filed. The only objection upon which the defendants were successful being thus disposed of, Mr. Justice Fry's decision on the patent as it now stands is on every point in favour of the Company. We think, therefore, that you may now congratulate the Company upon having two patents which have stood the most searching and hostile criticism which the ingenuity of a legal and scientific mind can bring to

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bear on them, and although it is, of course, possible that the great value attaching to those patents may induce some adventurous persons to carry the litigation to a higher court, if they can induce the public to find the money for the purpose, we have every confidence that they will fail in reversing the decisions which have already been given." I think that that announcement from Messrs. Waterhouse and Winterbottom must be very gratifying to all of us. To show you still more how the decision will act, we communicated with Messrs. Waterhouse and Winterbottom, and they say that some of our would-be opponents have been attempting to get up fresh companies to do this business, saying that they had the Hunnings transmitter to use in conducting the business. This Hunnings transmitter is a thing we went against all along, as we held that it was a childish infringement of our patent. This Hunnings transmitter was open to the public for a time, and we were told that those gentlemen had seized the opportunity of manufacturing a great number of them, so that they would be able to commence this business in competition with us, and obtain their cost, even if they could not uphold their case. However, Messrs. Waterhouse and Winterbottom state that the amount would only be calculated in connection with the transmitters manufactured *bonâ fide* prior to the date of our disclaimer. If such a question as this be referred to the Attorney-General for decision, he will, no doubt, decide in a manner satisfactory to both parties. You will, perhaps, expect me to say a word as to what I think is the value of our business, and so forth. I have no wish to induce any one to invest in telephone securities, but to the shareholders I would say that, under no circumstances, should you be in a hurry to part with your property. Although we are yet only able to pay a small dividend, you must not forget that the enterprise is still a very new one. We have overcome great difficulties, and I am certain that we are on the eve of overcoming much greater difficulties. We may meet with opposition and troubles of other kinds. We must expect that, but I do not waver myself from the constant belief I have always entertained, and that is that the United Telephone Company will triumph, as it has hitherto done, over all obstacles. I have no doubt that as regards competition from every and any source we shall continue to carry on this business as we have done with our utmost endeavours. Our greatest anxiety will be for the interests which have been confided to us, and I am certain that we shall prosper and triumph and prevail at the end. I do not know that I have anything more to say except that, of course, I shall be very happy to answer any gentleman who may have any question to ask on anything connected with the business. I shall only be too happy to offer the fullest information in our power.

Mr. R. H. Galsworthy observed that the revenue during the year was £42,624, as against £20,644 in the preceding year, or more than double, whereas the expenditure, although heavy, bore no proportion to the increase in the returns. If they were to go on there was no doubt that the Company would obtain a thoroughly good return. The number of their subscribers, he noticed, had increased from 914 to 1,673, and this appeared to him to be an admirable increase on the twelve months, but the chairman had not made any allusion to it. With reference to what had been stated regarding the Post Office, he was afraid that it was practically impossible to have successful competition in a business of this kind. Supposing there were a dozen telephone companies in London, there would be a terrible state of confusion. He expressed his satisfaction with the report, and he had no doubt that the dividend would increase if they continued to progress as they were now doing.

A Shareholder inquired the number of subscribers obtained since the report.

The Chairman stated that from the 30th of April, 1881, to the 30th of April this year the number of subscribers had increased from 900 odd to 1,600 odd, but from the 30th April to the present date the subscribers had increased from 1,600 odd to 1,924. They were now running their wires twice as quickly as they used to do. Mr. Morgan was at work all day long, and had discovered a way of doing the work better and more quickly. The board were satisfied that the income would steadily increase, while at the same time the management expenses would not show any large increase.

The Managing Director (Mr. Morgan) read a statement of the results of the working of the Company, and showed that they had increased by nearly 100 subscribers a month. In June of this year they had opened 130 wires. The number of exchanges in 1880 was seven, four more were opened in 1881, and three others in 1882, and one was opened at Smithfield during the last three months; this made 15 exchanges in all.

The resolution was then carried.

The Chairman proposed the payment of a dividend of 5 per cent., less income-tax, on the paid-up capital of the Company for the year ending the 30th of April last.

Mr. Forbes seconded the resolution, which was carried.

On the motion of the Chairman, the retiring directors, Messrs. J. W. Batten, J. B. Morgan, and Colonel Gouraud were re-elected; as were also the retiring auditors, Messrs. Quilter, Ball, and Co., and Messrs. Price, Waterhouse, and Co.

The Chairman then moved a resolution confirming the agreements referred to in the notice convening the meeting. He stated that the two companies mentioned were formed on the basis of the Lancashire Telephone Company and the National Telephone Company, which he said were going on in a fairly satisfactory way, and he hoped would be found of more value to this Company than they were even now. The capital of the Telephone Company of Ireland was proposed to be £200,000, £25,000 being preference shares of £5 each, and £175,000 in ordinary shares of £1 each, of which this Company would receive £85,700 in shares. The amount to be repaid to the Company in cash for the expenditure they had already incurred in Dublin and elsewhere in forming the nucleus of this business was about £5,500. As regarded the Western Counties Company, they proposed a capital of £275,000, of which £25,000 was in preference shares of £5 each, and £250,000 in ordinary shares of £1 each, of which this Company would receive £125,000, and the amount to be repaid to them in cash for the expenditure they had incurred was about £6,000.

Mr. Galsworthy asked if the Western Counties Company was formed yet.

The Chairman replied that it was as good as formed, as they knew a good many gentlemen who had agreed to take it up. The matter would have been completed before now but for some little hitch.

A Shareholder said he understood this Company was largely interested in three companies, and he would like to know how many subscribers they had, what towns they served, and whether they were sufficiently strong in those towns to hold their own.

The Chairman replied that he could not go into those details, as they did not properly belong to the business in hand. The Lancashire, the National, and the Northern Companies were fairly strong in all the towns they had licenses for. They had not succeeded in getting licenses for all the places they would like, but the new decision of the Postmaster-General would, no doubt, enable him to grant licenses for places where up to the present they had not got the requisite permission. There was a gentleman in the room who could give them the fullest possible information. He referred to Colonel Jackson, the distinguished chairman of the Northern Company. He (the chairman), however, might say that they were all going on very well.

Mr. Forbes seconded the resolution, which was carried.

Mr. Agnew, M.P., proposed a vote of thanks to the chairman and directors, who, he said, had managed the ship and piloted it through very troubled waters. He believed the shareholders would agree with him that they deserved a cordial vote of thanks.

Mr. Forbes said, leaving out the directors for the moment, he should like to second the motion in so far as it related to the chairman, their excellent friend Mr. Brand. A more earnest, courageous, and honourable man than that gentleman he did not believe could be found in the city of London. Had it not been for the energy displayed by Mr. Brand this Company would not have been in the position in which it was now.

A Shareholder seconded the resolution.

The Chairman briefly acknowledged the vote on behalf of himself and colleagues, and assured them that they would do their best to promote the welfare of the Company.

THE ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION (LIMITED.)

An extraordinary general meeting of the Anglo-American Brush Electric Light Corporation (Limited) was held at the Cannon-street Hotel on the 3rd inst., at twelve o'clock at noon, to consider the confirmation of the resolution passed at the extraordinary general meeting of the Corporation, held on the 18th ult., as reported in *The Electrician*. Sir H. W. Tyler, M.P., presided.

The Secretary (Mr. W. J. Cordner) having read the notice convening the meeting,

The Chairman said: As you will have seen from the notice, our business is to confirm the resolution we passed on the 18th July. The meeting is therefore held in accordance with the 51st clause of the Companies' Act, 1862. Having read the clause, he continued: In accordance with that clause we have summoned you within a month, and also at more than fourteen days from the last meeting, to ask you to confirm the resolution which you passed on the 18th July. I do not think, as I stated fully on that occasion the object of the resolution, that I need detain you on the present occasion at any great length. It is simply to enable us to distribute among you the sum of £245,000 which we hold at your disposal, and for which we have had the warrants prepared, so as to be able to furnish you with the very satisfactory interim dividend of 100 per cent. upon all you have subscribed to this undertaking. I beg, therefore, now to move that this resolution be confirmed:—"That the 85th of the Articles of Association be repealed, and that in lieu thereof the following be henceforth the 85th of such articles:—85. The directors may, from time to time, of their own authority, pay to the members in proportion to the amounts paid up, or credited as paid up, on the shares held by them respectively, such bonus and such interim dividends as in the judgment of the directors the position of the corporation justifies."

Mr. Sellon seconded the motion.

Mr. R. Hammond observed that it would be a great satisfaction to the shareholders to hear that 100 per cent. was being declared, but when shareholders were receiving a dividend they were glad to know, to a certain extent, or to have a hint, as to how the dividend was being earned. He, therefore, thought it was within the province of the meeting to ask the directors, through the chairman of the Company, to give a slight hint to the shareholders in that respect. He thought this was desirable for more reasons than one, as they were told outside that the policy of the Company, with which he was vitally connected, had been to cover the whole of England with sub-companies working enthusiastically for the Brush system, which was not so well known when he first became connected with the Company as it was now. The Brush machine had in fact been placed by him in parts where it was not known before, and he was daily engaged in pressing forward the fortunes of the Brush system. Outside the Company there were those who stated that no profits were being earned by the Company on their machinery branch, and they were told that this 100 per cent. had successfully been made by selling concessions. They were told also that the Company was losing money on its manufacturing branch. He, therefore, thought that shareholders were entitled to have a hint as to whether the 12½ per cent. dividend which had been already paid on the working branch would not be a mere bagatelle compared to what was likely to be distributed in future out of earnings in the same direction. He thought the board could have no objection to stating that the Company was in a solid position, irrespective of the money made out of these concessions.

Mr. Baker inquired the amount of concession money still retained after the proposed distribution was paid.

The Chairman, in reply to Mr. Hammond, said it was quite true that this Company had formed a great number of sale companies, and they did that with this object—they said to themselves that the introduction of this system of electric lighting, or any other system, not only throughout the United Kingdom but also in a great number of foreign countries, was a gigantic business, and one which they could not possibly undertake with their limited capital, and, therefore, in order that it might be properly transacted it was desirable for them to engage other people who would assist in such a great work. And in order to do that they said that at a reasonable price they would sell concessions for different parts of the United Kingdom, and for those foreign countries for which they held patents, and so induce a great number of others to work with them, and form other companies, for whom they would manu-

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facture the requisite appliances. Unfortunately, instead of the business being conducted in a reasonable manner, as they had hoped when they started, it had come to this—that they had found that it had led to a great deal of speculation, and that though they sold their concessions at a very moderate price (having, indeed, had a difficulty in starting them, and Mr. Hammond had been greatly instrumental in promoting the work) they found that people had come crowding on them to buy the concessions, and that complaints were made that they could not get all they wanted; and not only that, but the people to whom they had sold concessions with the object that they should extend the light had begun to sell sub-contracts. They had, therefore, come to this—that there had been less lighting than the Company could have wished, and more of the sale of sub-concessions than they could wish, and what he regarded as an unhealthy state of things. The value of this Company's shares had been run up to a very high price—indeed, too high a price—and there had been a sort of mania. They looked on that as very disadvantageous, as they wanted to see their business reasonably conducted. They only made up their accounts annually, but when Mr. Hammond said that ignorant people outside were assuming that the thing was a sham, and wanted to know how their dividends were earned, the directors could only smile. The shareholders had only to go and see the works of the Company, and then they would see that instead of its being a sham there was a great deal of work being daily performed in the manufacture of apparatus, that they had no less than 800 men employed in the business, and that their manufacturing profit for the last six months had been at least £30,000. Whether that was the worse year or the better half year he was not going to prophecy. He did not think he ought to answer Mr. Baker's question any further than to say, as he stated at the last meeting, that on the rough balance-sheet which had been produced they had determined to divide the amount of £245,000, and that in order to protect themselves they had taken care that there was a very large margin in hand. They thought under all the circumstances that the sum he had mentioned could be divided among them.

Mr. Wood, speaking as a *bona fide* shareholder, wished that the chairman had taken the shareholders more into the cofidence of the board, so as more effectually to dispel the ugly rumours which were circulated as to speculation.

The Chairman thought that he had taken them entirely into his confidence, but he was intentionally guarded in what he said in order that they might have nothing whatever to do with speculation. He would not say a word if he could help it that should either tend to put up or to lower the price of their shares. Replying to another question, he added that as to the margin in hand to which he had referred, a large portion of it was in paid-up shares of the subsidiary companies, which they had taken as cash, and which they had been obliged to take in some cases. He then put the resolution in the usual way, and declared it carried.

A vote of thanks to the chairman closed the proceedings.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Aug. 2.		Business Done Week Ending Aug. 2. Highest.	Lowest
Anglo-American	49,	50	50⅜	49¼
Do. Preferred	79,	80	80	79
Do. Deferred	19,	20	20⅜	19⅜
Brazil Submarine	11⅜,	11⅝	11⅝	11⅜
Cuba	9¼,	9¾	10⅛	9⅝
Do. Preference	15¼,	16¼	—	—
Direct Spanish	6,	6½	6 5-16	6⅛
Do. Preference	15½,	16½	—	—
Direct United States Cable	11½,	12	11⅞	11½
Eastern Telegraph	10⅝,	10⅞	10⅞	10
Do. 6 per Cent. Preference	12¾,	13	13¼	12 5-16
Do. 5 per Cent. Debentures, 1899	100,	105	—	—
Eastern Extension	11¼,	11¾	11⅝	11½
German Union	9¾,	10¼	—	—
Globe Telegraph and Trust Company.	6¼,	6½	6 7-16	6⅛
Do. Preference	12¼,	12¾	—	—
Great Northern	12¼,	12¾	12 9-16	12⅜
Indo-European	28½,	29½	—	—
Mediterranean Extension	2,	2½	—	—
Do. Preference	8½,	9	—	—
Reuter's	12¾,	13¼	—	—
Submarine	265,	275	269	269
West India and Panama	1½,	1¾	1 9-16	1 9-16
Do. 1st Preference	8¼,	8¾	—	—
Western Brazilian	6¾,	7¼	7⅛	7⅛
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	103,	106	106	106

TELEPHONES.

Consol. Telephone and Maintenance	1¼,	1¾	1⅜	1¼
Oriental	⅜,	⅝	⅝	⅝
United Telephone	11¼,	11¾	12⅛	10⅜

ELECTRIC LIGHT.

Electric Light and Power	⅜,	⅝	⅝	7-16
Anglo-American Brush	16½,	17½	19⅜	16½
Eastern Electric	2¾,	3¼	3⅜	3

TRAFFIC RECEIPTS FOR JULY, 1882.

Companies.	June, 1882.	June, 1881.	Incrse.	Decres
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	30,070	31,751	—	1,681
Eastern Telegraph Company	—	—	—	—
Great Northern Telegraph Company	—	—	—	—

RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

3809. Improvements in Apparatus for and Arrangement of Telephonic Exchanges, *C. D. Abel, London.—1st September*, 1881.—*(A communication from La Société Générale des Téléphones, Paris.)* 6*d*.

According to the arrangements included in this invention there are two wires to each circuit, and seven sets of these double wires are grouped in cables, thus one cable serves for seven subscribers. The cables are led into the building through a metal plate attached to the wall, which has as many separate holes as there are cables. From this plate the cables are led along channels to the "rosace" or apparatus by which the connections are established between the conducting wires and the exchange apparatus, one-half being led to the top and the other to the bottom. The ends of the cables are then spread out and each attached to a stud, whence the seven pairs of wires are spread out, the different pairs of wires are then separated and attached to a disc with the name, &c., of the subscriber. The other connections are then made in such a way that it is easy to group the cables on the rosaces, so that at the commutators the subscribers that communicate most often with each other have their "jack-knives" nearest to each other. Other improvements are also described.

3822. An Improved Electric Lamp or Regulator, *A. Turbini, London.—2nd September*, 1881.—*(Not proceeded with.)* 2*d*.

This invention consists in the regulation of carbons resembling the Jablochkoff candles, and covered with a non-conducting substance, which carbons are placed side by side, and the distance between them regulated by the action of a solenoid coil and core in the circuit.

3857. A Perpetual Electro-magnetic Motor, *C. Le Sueur, Paris.—5th September*, 1881.—*(Not proceeded with.)* 2*d*.

This invention consists in an arrangement of horse-shoe magnets, some inside a fixed ring, and some in a movable shaft, in such positions that a continuous rotary motion is obtained.

3898. Improvements in Apparatus for Igniting Gas for Illuminating by Means of Electricity, and in Batteries Connected therewith, *A J. Hallam, Salford, and J. Walsh, Over Darwen, Lancashire.—8th September*, 1881.—*(Not proceeded with.)* 4*d*.

The inventors use two metal pillars with screw pins above each gas jet, the current leaping across from pin to pin and igniting the gas. The invention also relates to a means for lighting large districts at once by means of sliding contacts at a central point, and to an improved battery for this purpose.

3946. Improvements in or Applicable to Telephones, *W. E. Irish, Sunderland.—12th September*, 1881.—*(Not proceeded with)*. 2*d*.

This invention consists in the substitution of a piece of platinum or carbon, supported by an insulated spring, so as to reach the centre of the diaphragm, where another contact piece is carried for the usual magnet; the battery and line wires are connected to the respective contacts.

3975. A New or Improved Mode of and Appliances for Carrying or Laying Electric Wires, *J. W. Smith, Edinburgh.—14th September*, 1881. 6*d*.

This invention consists in making the curb stones and causeway blocks of streets hollow, so that the wires can be carried therein, provision being made for them to enter in or pass out where required.

4026. Improvements in Dynamo-electric and Magneto-electric Machines, *E. de Pass, London.—19th September*, 1881.—*(A communication from La Société Anonyme des Cables Electriques, Paris.)—(Not proceeded with.)* 2*d*.

The principle of the invention is that of a fixed circuit, within which a Siemens coil or an electro-magnet is arranged, the wires of which always receive a current in the same direction, whilst the surrounding coil is traversed at each half revolution by reverse currents.

4037. Secondary Batteries, *W. Clark, London.—19th September*, 1881.—*(A communication from N. de Kabath, Paris.)* 6*d*.

This inventor claims the use of laminated and corrugated sheets of lead.

5116. Incandescent Burners, *H. J. Haddan, Kensington.—23rd November*, 1881.—*(A communication from W. M. Jackson, Providence, U.S.)—(Complete.)* 6*d*.

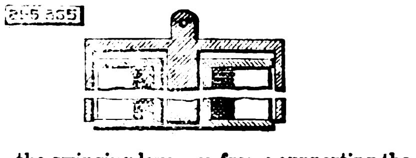
This relates to improvements in devices for producing illumination by the incandescence of a suitable substance heated to a proper degree by means of burning gases or vapours, and is specially designed to utilise the non-luminous gases, such as hydrogen, carbonic oxide, or a mixture of such gases which either possess no carbon whatever, or do not contain it in such condition as to be rendered luminous when burning.

5221. Apparatus to be Controlled and Operated by Electricity for Stopping Trains and Giving Signals on Railways, *W. R. Lake, London.—29th November*, 1881.—*(A communication, W. C. Schaffer, Philadelphia, U.S.)* 6*d*.

The apparatus connected to the steam, air, or other means of actuating the brakes, is set in motion or stopped in action by electric contrivances.

255,365. Electro-Magnet, *Edward Weston, Newark, N. J., assignor to the United States Electric Lighting Company, New York, N.Y.—Filed August 10th*, 1881.

Claim.—(1) The combination, with a hollow helix of insulated wire, of a movable armature composed of a central core extending entirely through the helix, and an inclosing shell of iron, of equal length therewith, substantially as set forth. (2) The combination, in an electric lamp,



with the swinging lever or frame supporting the feed-regulating mechanism, of a hollow stationary helix composed of one or more coils of insulated wire, as described, and a movable armature consisting of a central core capable of extending entirely through the helix, and an inclosing shell, of iron, of equal length therewith, substantially as shown and descrbed.

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4255. Secondary Galvanic Batteries, *A. Watt.*—1*st October*, 1881. 4*d.*

The inventor uses lead coated with a mixture of calcium hydrate, manganese dioxide, and sodium or calcium chloride, or the material known in the alkali trade as Weldon mud, mixed with pulverised coke or granulated lead. A second form has alternate layers of carbon and manganese dioxide.

4478. Improvements in Electric Lamps, *R. Harrison, Newcastle-on-Tyne.*—14*th October*, 1881. 6*d.*

This relates to incandescent lamps. The inventor punches his carbon filaments out of carbon, using a V-shaped punch. The two ends are widened out and have eyelet holes punched in them, into which are inserted metallic eyelets. To these eyelets are attached the metallic connections, after carbonisation, to which in turn the wires are attached. To provide for one light taking the place of another the inventor connects them with a shunting apparatus. This consists

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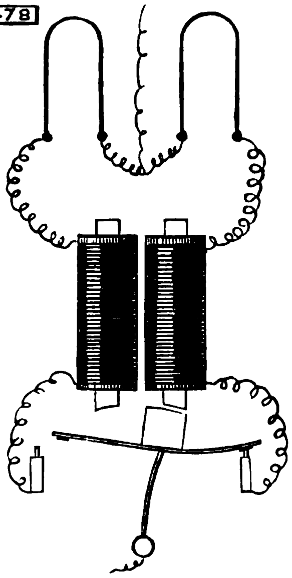

of a small electro-magnet for each light; in front of the poles of the two electro-magnets an armature is mounted free to be attracted by either; to this armature is attached a spring, which in the middle position of the armature bears slightly against two contacts, one for each light. When either has the greater part of the current passing through it, the electro-magnet in that circuit attracts the armature, so that its spring makes a firm contact for that circuit, but is taken out of contact for the other. The figure explains the apparatus.

4552. Improvements in Dynamo or Magneto Electric Machines, *P. Jensen, London.*—18*th October*, 1881.—(*A communication from T. A. Edison, Menlo Park, U.S.*) 6*d.*

The object of this invention is to regulate the generative power of a dynamo machine so that only as much current as is required may be

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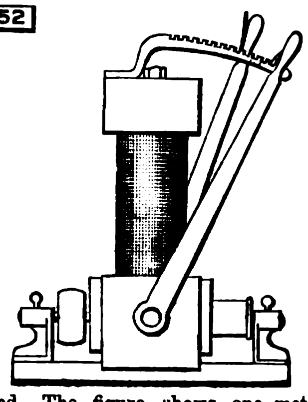

generated. The figure shows one method of doing this. The two levers are of soft iron, and make contact with the yoke when in line therewith. The levers become magnetised, diminishing thereby the strength of the lines of force in the magnetic field, and the upper end of each lever has a polarity opposite to that of the particular pole of the magnet to which it is connected. Consequent poles are thereby established in the yoke of the magnet opposite the ends of the levers, which poles are increased in power by the approach of the levers to the yoke, and the lines of force are shunted away from the field in which the induction bobbin rotates more or less, according to the distance of the levers from the yoke.

4504. Improvements in Electric Arc Lamps, *J. Brockie, Brixton.*—15*th October*, 1881. 6*d.*

This refers to improvements on patent No. 3071, dated 19th September, 1879. One improvement consists in lamps with two or more pairs of carbons, so arranged that when one pair is consumed another will be lighted. The figure shows one method of doing this. When a current is passing the shunt magnet M attracts armature C, which lifts both holders, thus separating the carbons, the arc being formed between the pair having the least resistance, or that happened to be last in

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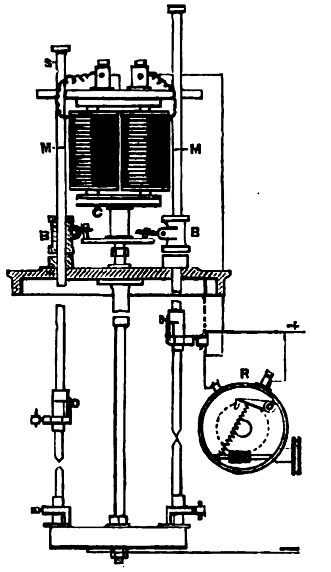

contact. When M is momentarily cut out by an arbitrary interrupter R revolved by the engine or dynamo, the armature leaves the magnet, allowing clutches B B to relax their grip of the carbon holders, thus permitting momentary contact between the two pairs of carbons, and then lifting them up again the correct distance for the arc, which will be established between the same pair of carbons as before. This will be repeated until the carbon holder is stopped in its descent by S, when the arc will be transferred to the other pair. Other improvements are also described.

4576. Improvements in Meters for Measuring Electric Currents, *E. G. Brewer, London.*—19*th October*, 1881.—(*A communication from T. A. Edison, Menlo Park, U.S*) 6*d.*

This relates to a meter consisting of a cell, in which the metal from one plate is deposited on the other by the action of a definite fraction of the current entering a house to supply electric

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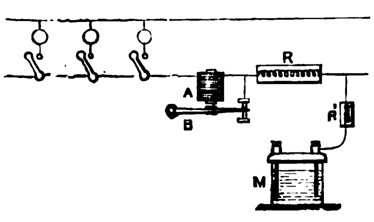

lamps therein. In order to obtain a correct deposit of metal on the plates with a weak current the plates of the cell are composed of metallic zinc placed in a solution of sulphate of zinc, such plates having a heavy coating of deposited zinc placed on them by the action of an electric current prior to being used in the meter. To provide for a definite small proportion of the current going through the meter a resistance is placed in the line. A wire resistance is placed in the same shunt as the cell, and is arranged so that should the temperature rise the resistance of the wire is increased and that of the cell proportionately decreased, and *vice versâ*, for a fall of temperature. Thus the same fracture of current will always pass through the cell. To prevent a counter current in the cell when no lamp is in circuit, a device is provided for automatically breaking the shunt when the circuit of the last lamp is broken. In the figure R is the resistance in main conductor, M is the cell, R^1 the wire resistance in shunt circuit compensating for varying temperature. A, electro-magnet operating lever B, and breaking or making contact with shunt circuit. The inventor also describes a means for automatically regulating the temperature of the cell so that the solution cannot freeze, and other improvements.

4541. Improvements in the Generation, Collection, and Distribution of Electro-magnetic Currents, and in the Apparatus Employed Therein. *R. Kennedy, Paisley.*—18*th October*, 1881. 6*d.*

The figure shows the construction of the machine. A A are the field magnets, with horizontal members wound with coils A^1 A^1. The shaft driven by a pulley carries an exciting armature, and a number of separate armatures, which the inventor calls working or collecting armatures. These are of wheel form, having a number of projecting soft iron pieces secured to their peripheries, between which the wires are wound in coils, the wires between each two adjacent spaces being connected together, and a wire led from each connection to the commutator, which consists of a

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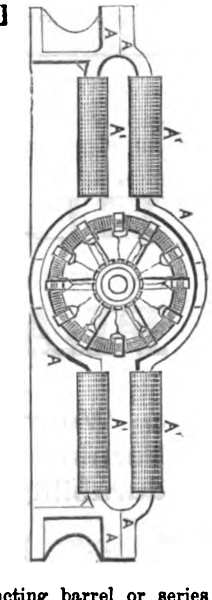

non-conducting barrel or series of discs. The barrel carries a series of rings separated from each other; the said series carry plates equal in number to the total number of divisions on the armatures employed, together with a ring for the exciting armature to give a separate current for this armature. The wires of the armature coils are led one to each plate of a ring of the commutator, each ring receiving the wires from one armature. Collecting springs bear upon opposite sides of each ring, and collect a separate current from each, so that each current may be utilised separately, or they may be united and used collectively.

4070. Improvements in and Relating to Indicating Apparatus or Signals for Railway Switches or Points, *W. P. Thompson, Liverpool and London.*—21*st September*, 1881.—(*A communication from W. W. Gary, Boston, U.S.*) 6*d.*

This invention consists in causing the train to operate the signal indicating whether points are open or closed. A signal, a magneto-generator, operated by a passing train, and a circuit-closing device and a switch are so connected that the circuit will be opened or closed by the act of opening and closing the switch. The signal is normally at danger, whilst the circuit is closed as well as the switch. An approaching train will actuate the generator, from which a current will be sent to the signal, which will fall and indicate safety, if the switch be closed. If it be open, the circuit will be broken, no current will be sent to the signal, which will consequently remain at danger, warning the driver of the train that the switch is open.

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BOROUGH OF KIDDERMINSTER.

The Improvement and General Purposes Committee of the Town Council are prepared to receive TENDERS for the LIGHTING of the BOROUGH for one year. Tenders may also be sent in for lighting the principal streets only.

Full particulars, together with a Plan of the Borough, may be obtained at my Offices on application. Tenders to be delivered to me, not later than 10 a.m., on AUGUST the 9th, endorsed "Tender for Lighting."

The Committee do not pledge themselves to accept the lowest or any Tender.

ARTHUR COMBER, Borough Engineer.

Town Hall, Kidderminster,
July 25th, 1882.

TO ELECTRIC LIGHT COMPANIES.

CONTRACTS WANTED for LIGHTING Estates at Wallington, Carshalton, and Raynes Park, adjoining Wimbledon, Surrey; the Lord of the Manor Estate, Ashford, Middlesex; and Theydon Park Estate, adjoining Epping Forest.

Apply to the Freeholder, I. ABRAHAMS, Esq., F.R.S.L., F.S.S., &c., 65, Russell-square, W.C.

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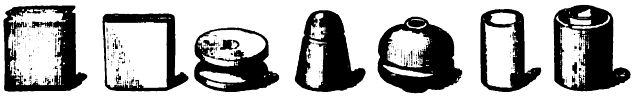

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Cable Repaired.—The Western and Brazilian Telegraph Company notify the repair of their Rio Grande do Sul (Monte Video) cable.

Jersey.—During the latter part of last week telegraphic communication with Jersey and Guernsey was interrupted for several hours, but has since been restored.

Direct Spanish Telegraph Company.—The estimated traffic receipts of this company for the month of July, 1882, were £1,846, against £1,448 in the corresponding period of last year.

Alexandria.—News from this town received during the week states that arrangements have been completed for throwing the electric light over the enemy's lines from Ramleh.

Electric Light in London.—The entrance to the Arundel Hotel, in Norfolk-street, Strand, is now lighted by a Brush lamp, whilst a similar lamp lights the Embankment side of the building.

The New Atlantic Cable.—A telegram from New York says that the Cable Bill has passed the Senate with an amendment which limits the charges to 20 cents a word. This refers to the Garrett cable.

A Name.—Instead of the hybrid word "scientist," a writer in the *St. James's Gazette* of August 4 suggests the word "scientiate," following the Italian, and thus deriving another word from the Latin through one of her children.

Electric Light in Liverpool.—The premises of Mr. Wm. Lea (known as "The Liver," in Church-street, Liverpool) have recently been lighted by means of Pilsen arc lamps. The lights were erected by Messrs. Rawson and Woodhouse, of London.

Great Northern Telegraph Company.—The traffic receipts of this company for July amounted to £21,640; for the period from 1st January to 31st July, 1882, they were £137,200, against £137,166 for the corresponding period of 1881, and £131,313 for the same period in 1880.

Tampering with the Electric Light.—For maliciously extinguishing the electric light in St. Enoch Station, Glasgow, Peter Smith, who had been an *employé* of the Glasgow and South-Western Railway Company, was fined two guineas, with the alternative of twenty days' imprisonment, at the Central Police Court of Glasgow the other day.

The Telephone in Sheffield.—The number of calls over the lines of the Sheffield Telephone Exchange the week before last amounted to 7,658, being the highest number since it began operations. On the Wednesday of the above-mentioned week no less than 306 calls were recorded between 10 and 11, the number during the day being 1,346.

Electric Lighting.—Tenders are being invited for lighting estates at Wallington, Carshalton, and Raynes Park, near Wimbledon, Surrey, and the Lord of the Manor Estate, Ashford, Middlesex; also Theydon Manor Estate, adjoining Epping Forest, by means of electricity. For further particulars application should be made to Mr. J. Abrahams, 65, Russell-square, W.C.

Reduced Rates for Telegrams.—Replying to Mr. R. Paget in the House of Commons on Thursday week, Mr. Fawcett said he could not see his way to allow a telegram of twenty words, answer prepaid, to be sent for 1s. 6d. Although he should be very glad when the time came that the price of telegrams could be reduced he did not think that it would be expedient to charge a smaller sum for a reply message than for the telegram first sent.

Telegraphy in Liverpool.—The system of the Exchange Telegraph Company, which has done such useful work in London for some years past, has now been introduced into Liverpool. On Tuesday week work was begun at No. 71, Lord-street, Liverpool, home and foreign news, parliamentary intelligence, &c., being transmitted to various points on the Exchange Company's well-known system. It is intended, we believe, to open an office in Manchester very shortly.

The Electric Light at Edinburgh.—The electric light, which has been in use in the main portion of the Waverley Station, Edinburgh, since August last, has proved so useful that it is now being introduced to the outlying platforms devoted to local traffic. At the east end of the station nine lamps have already been erected. One of these is fixed on the east wall of the North Bridge, and will illumine the long flight of stairs there. On the western platforms lamps will also be fitted up.

The Telephone for the House of Commons.—In the House, recently, Mr. Gray asked the first Commissioner of Works whether he would consider the desirability of placing the House of Commons in telephonic communication with the Telephone Exchange, and also of placing one of the Exchange telegraph instruments in the House for the convenience of members. In reply, Mr. Shaw-Lefevre was understood to say that he hoped during the recess to make arrangements in the direction suggested. The only difficulty was to find a suitable room.

Accident Caused by Electric Light Wires.—An accident, attended with fatal results, occurred on the evening of Sunday last, 6th August, in the Tuileries Gardens, Paris, during a display of fireworks. It appears that two men, in attempting to climb over the railing, caught hold of the wires carrying the current to some electric lamps used for the illumination of the grounds, and were struck dead on the spot, all efforts to restore them to life proving ineffectual. A correspondent informs us that one was an infantry soldier and the other a young man about seventeen years of age.

Cable Laying off Egypt.—In all probability before these lines are read a cable will have been laid between Alexandria and Port Said by the Eastern Telegraph Company's ss. "John Pender," so that the fleet will have direct cable communication to England. The work was commenced on Tuesday last, the "John Pender" having arrived off Alexandria on the previous Sunday. Prior to her departure for Egypt she had been engaged on the Eastern Telegraph Company's Porthcurnow-Lisbon cable, but on receipt of the decision of the Government to lay the new cable, she was at once ordered to Alexandria.

Electric Light at Coventry.—On Monday night the cricket ground at Coventry was illuminated with the electric light, and, at the request of some of the citizens, it was decided to utilise it on Tuesday evening for an exhibition football match. The teams were selected from local clubs, and play commenced about nine o'clock, in the presence of 1,500 spectators. It is stated, however, that the denseness of the shadows thrown rendered it impossible for a great deal of skill to be exhibited. In the "scrimmages" the ball was not unfrequently "missed," and in one or two instances the shadow was mistaken for the substance. Play was continued for about an hour.

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Electric Light at Paisley (Scotland).—The Edison Electric Light Company have just completed the introduction of their system into the house of Mr. Coats, at Woodside, Paisley. The two dynamos which supply the current are driven by a $12\frac{1}{2}$ h.-p. (nominal) engine, placed in a buiding a short distance from the house. There are altogether about 200 incandescent lamps distributed throughout the house and adjoining buildings, those in the house being A lamps of 16 candle-power fitted to the gas-brackets, and those in the greenhouses, &c., being B lamps of 8 candle-power. Safety catches are provided as in all installations of the Edison system, so as to ensure safety from fire.

Telegraph Stores Wanted.—Tenders are invited for the supply of 60 Hughes instruments, 1,800 Morse receivers, 8 transmitters, 8 Wheatstone receivers, 80 Wheatstone perforators, 1,400 sounders, 1,500 bells, 2,200 galvanometers, 1,700 Morse pegs, 3,700 commutators, 4,400 lightning conductors, 15,000 brass terminals, 60,000 porous cells, 172,000 zinc battery plates, 16 tons bi-oxide of manganese, 10 tons chlorhydrate of ammonia, 90 tons sulphate of copper, 3 tons copper wire ·08in. diameter, fittings for induction coils, and other miscellaneous stores. Particulars may be obtained at the Ministère des Postes et Télégraphes, Paris, where tenders will be received up to the 22nd August.

Scientific Observatories at the North Pole.—In a recent paper, describing the observatories that are about to be established in the Polar Regions by the German and other Governments, Professor Neumayer said that the Cumberland Strait Station is notable for its position near the magnetic North Pole, it being also not very far from the centre of the magnetic forces of the earth. The difficulties of this situation, consisting in the disturbances produced by the magnetic currents, are obviated by peculiarities in the construction of the instruments to be employed there. He also stated that a conference of the directors of meteorological stations is to be held at Copenhagen to consider the desirability of laying a telegraph cable from Canada through the region traversed by the great storms of the American Continent, so as to make it possible to foretell the future weather for five or six days, whereas, at present, the weather predictions of the *New York Herald* are of little practical value.

New Company.—The prospectus has been issued of the London and Globe Telephone and Maintenance Company (Limited), with a capital of £600,000, in £1 shares, the first issue of which is £270,000. The company has been formed to supply an improved and less expensive telephonic communication than at present in use, the Postmaster-General having intimated his intention to throw open the telephone business of the country. Arrangements have been made to acquire certain patent rights, including those for the "Dolbear" Telephone Receiver and Transmitter, and "Anders" Microphone Transmitters, also certain switchboards and the Skrivanow dry battery. It is proposed to introduce a system of day and night service, by means of which subscribers can be placed in constant communication with the fire stations, hospitals, and police, &c. The vendors are to receive £40,000 in cash and £90,000 in fully-paid shares, this amount including £5,000 in shares which has been paid for the Hunnings Transmitter patent. The patent rights have been secured for Great Britain and Ireland, as well as the Continent. The consulting electricians are Professor Dolbear, Professor Silvanus P. Thompson, and Dr. Alexander Muirhead. The electricians are Mr. G. L. Anders and Mr. J. B. Henck, jun., both of whom were formerly electricians to the American Bell Telephone Company. The secretary is Mr. J. Ford, and the offices are at 31, Queen Victoria-street, E.C.

A Locomotive Telegraph.—A system for enabling a railway train in motion to send and receive telegrams was recently tried on the Altanta to Charlotte aerial railway in America. It is the invention of Captain C. W. Williams, of the United States Army, and consists of a telegraph wire running along the track, but insulated from it, and interrupted at intervals of 40ft. The ends at each break are connected to copper rollers, which normally are in contact, so that the electric circuit is completed through them. One car of the train is fitted up as a telegraph office, and two long metal strips or rails projecting from below the car rub against the metal rollers as the car passes. In doing so they depress the rollers, thus causing them to break contact with one another. The strips are connected together through the instruments in the car, and the electric current passes from one roller through the instruments to the other roller, and thence traverses the rest of the wire. The circuit through the apparatus thus established is never absolutely interrupted, for as the car moves from one pair of rollers to the next, the strips make contact with the latter just before contact with the former is broken. The instruments, in fact, are constantly moving along the telegraph line as the train itself moves, and hence a message can be recorded on them or despatched. Telephones can be used as well as the ordinary Morse and sounder instruments, and the system enables a passenger to send or receive a telegram while travelling, or the position and state of the train to be communicated to a distant station.

The Proposed Exhibition at the Aquarium.—It has been decided by the organisers of the proposed electric exhibition at the Royal Aquarium, Westminster, to offer a prize of £100 for the best storage battery that may be shown. The battery to remain open to investigation at any time. A prize of £100 will also be given for the best system of incandescent lamp, on the following conditions:—Each competitor will be allowed to exhibit a chandelier or electrolier, capable of supporting 100 incandescent lamps, the current being supplied by a separate dynamo and engine. The electrolier will only be inspected once in the day, when the number of lamps that may be broken or damaged will be registered. The power absorbed by the lamps will be measured (at the machine straps), as also will the light given by the lamps, and both these measurements will be registered against the system of lighting as often as they are taken. We may mention that a separate prize will be given for the best design of electrolier, regard being had to its cheapness and effectiveness rather than to anything very ornate. In the final prospectus, which has just been got out, additions have been made to the list of exhibits for which prizes will be given, and it now includes the following:—(*a*) The best method of heating by electricity, (*b*) the best compound for insulating wires, (*c*) the best gas or water motor for driving dynamos. The organisers of the exhibition announce their intention of choosing the jurors, so as to avoid as far as possible any suspicion of partiality or favouritism in the distribution of the awards. The exhibition throughout will be of as practical a nature as it is possible to make it. The organisers have certainly begun well, and if they act up to their prospectus and intentions the exhibition at the Aquarium ought to be a good one and a success in every way.

The Electric Lighting Bill.—In a lengthy letter to *The Times* of the 7th inst., Mr. J. Fletcher Moulton, F.R.S., who, it will be remembered, represented the collective interests of the electric light companies before the Select Com-

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mittee on the above Bill, explains why it was that the purchase clause was allowed to pass without much opposition on the part of his clients. We regret that we cannot find room for this letter in full, but must content ourselves with extracting the pith of it. Mr. Moulton describes the position of his clients in the following words:—"They approve the Bill because the purchase clause, as it at present stands, is such a monstrous disfigurement of an otherwise liberal and wise piece of legislation that they are convinced that the existence of that clause in its present state can only be very temporary." Mr. Moulton then goes on to explain how it was that such a short period as 14 years crept into the purchase clause, premising that there was not one tittle of evidence given before the Committee to lead to the choice of such a short period, but that on the contrary, all the evidence pointed to a very much longer period as being absolutely necessary; certainly 21 years, possibly longer. The explanation is as follows:— "That while the Bill was being drafted, the Board of Trade sent privately a few copies to prominent directors of electric lighting companies, and one or two other persons, for their opinion of its provisions. . . . At that time the purchase clause stood as follows:—The number of years was seven. There was no provision for compensation for severance if part of the works were taken at the price of old materials." Mr. Moulton then explains that these gentlemen pleaded for 14 years instead of seven. He declares that, to the best of his belief, only one of these gentlemen had any practical experience in incandescent lighting, and he afterwards stated that he "was certain that 21 years was the smallest period that should be allowed." The other gentlemen were "comparatively unacquainted with the expense or the practical details of electric lighting of either kind." The position of the companies was then that they must either accept the clause as it was or run the risk of delaying the passing of the Bill until next year. They chose the former alternative, but not because they were satisfied with the clause; on the contrary, to quote Mr. Moulton, "it is universally felt by . . . . that its terms are oppressive and wholly unjustified by the circumstances of the case." Mr. Arnold White, secretary of the Edison Company, writes in the same issue of *The Times*, stating that "the Edison Electric Light Company fail altogether to recognise the justice of the provisions of the purchase clause in the Bill, and it is only on account of the *force majeure* of the necessity for acquiring certain powers given in the Bill, which are requisite to the general use of the light, that they give a reluctant assent to its passing at all." We may call our readers' attention to the debate in the House of Lords, a report of which will be found in another column, from which it will be seen that their lordships have amended the purchase clause by the insertion of 21 years instead of 14.

Telegraphic Communication with the East.—Several letters have appeared in recent issues of *The Times* on this subject, in answer to the article in that paper which we criticised in our issue of last week. We give a summary of the chief points of the correspondence. Mr. H. G. Erichsen, representative of the Great Northern Telegraph Company in England, thinks that the manner in which the company's lines are referred to in *The Times*' article points to the conclusion that their importance has not been duly appreciated. He states as evidence of their value that "for years past, from one-third to one-half of all the telegrams exchanged between Europe and Hong Kong, China, and Japan have passed over the company's lines." He also points out that in case of emergency, such as is alluded to in the article, "the company's lines in connection with the lines west and south of Hong Kong are perfectly able to carry the traffic to Australia, India, Aden, and South Africa."—"W. I. R." points out that if a cable had been laid *viâ* the West Coast of Africa some time since, the expense of the transport of the 2nd West India Regiment from the West Indies to the Gold Coast might have been saved, since Lieutenant-Governor Griffiths was able to report on the 6th February, 1881, after he had been reinforced by other troops and certain ships, that he did not want more troops. Owing to there being no telegraph to the Gold Coast, however, this report did not reach England in time to stop the embarkation of the 2nd West India Regiment. This correspondent thinks that were such a cable laid the money it would save in this and other ways would pay the interest on a Government loan to defray the cost of laying it.—Dr. C. W. Siemens argues in favour of a cable to the Cape, *viâ* Ascension and St. Helena, and thence to India, *viâ* the Mauritius. "The cable would," writes Dr. Siemens, "be situated in deep water throughout nearly its whole length, where, according to our present knowledge of telegraphic engineering, it would be much more securely placed than in shallow water, and could, in case of need, be picked up with almost the same facility." Dr. Siemens then refers to the Indo-European line (with the construction of which he was intimately associated) as by no means so liable to interruptions from political causes as is often made out in this country, and concerning which apprehensions are expressed in *The Times*' article. In proof of this he points to the respect which was paid to the neutrality of the line during the Franco-German and Russo-Turkish wars, as well as during "the critical period of the subsequent peace negotiations at Constantinople, when the English despatches passed without hindrance over the Indo-European line, *viâ* Odessa." He also points to the fact that this line is now the only means of communication between England and her eastern possessions, and that it does not prove "insufficient or unreliable under these trying circumstances, land line though it be."—Sir James Anderson would be very glad if he could see any possibility of securing a "revenue or subsidies to justify the expenditure of capital to fill up the broken link requiring an additional 4,510 miles of cable, if the direct route from the Cape Verds *viâ* St. Helena to the Cape were selected, and 6,000 miles, if the cable were landed at the trading stations along the west coast of Africa, but excluding the islands of Ascension and St. Helena." Not that there will be any traffic sufficient to pay interest upon the capital required, and the cable, therefore, must be laid at the cost of Government. The cable would not, he thinks, be any the less easily cut because it is laid in the deepest part of the ocean; and then, again, this, combined with the effect of the trade winds, would make repairs a tedious and expensive operation. To continue the present South African cable to Mauritius—as bad a part of the ocean in which to maintain a cable as can be found—and thence to Point de Galle, in India, will require 5,000 miles of cable, Sir James Anderson says. Concluding, Sir James sums up the elements necessary to preserve cables in safety, and to make them pay, none of which he thinks are presented in the proposition contained in *The Times*' article. In addition to which he is of opinion that when Egypt is tranquil again, as it certainly will be, the route *viâ* Egypt and the Canal will be made secure against all interruption for many years to come.

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THE GREAT PRIMORDIAL FORCE.

By Henry Raymond Rogers, M.D., Dunkirk, N.Y.

[The correspondence as to "What is Electricity?" also that which has arisen out of it, must soon close. Meanwhile, this paper, which was read before the American Association for the Advancement of Science last year, may interest many readers.—Ed. *E.*]

The law of "*Conservation of Force*" having received the full and unqualified endorsement of all true scientists, is to-day the basis of all physical philosophy and the key to the explanation of all physical phenomena. No view of force can henceforth be accepted which is incompatible with it.

It may be said to be the product of the last half century, its origin being obscure and uncertain. Its earlier conceptions evinced but little promise of the grand future that awaited it, and its advancement, like that of all fundamental truths, has been exceedingly slow. It must be confessed that to-day, even, our knowledge of its provisions is but the *rudimentary.* In the way of applying it to the explanation of the mysteries of nature's varied phenomena but little has yet been done. We are confident that whenever this immutable law shall be properly applied, a new era will have dawned upon physical science.

Another fundamental principle of recent discovery has been developed *pari passu* with that mentioned, and in importance is only secondary to it, viz., the "Unity of Force," the correlation of all the forces. It has been demonstrated that all forms of force are resolvable into one another; it is, therefore, manifest that whatever name, or designation, we may give to these varied forms, but one essence pervades and animates them all. Instead of many independent forces, set forth in an irrational, contradictory, and mostly complicated philosophy, actually there exists *One Great Primordial Force;* simple in its character, competent to explain all physical phenomena, and in harmony with the nature of things. It is the force that rules the universe of matter, innumerable star-suns and minutest atoms alike; and, for its realm, it has the vast bewildering space and all the cosmical bodies which occupy its depths.

This force is real and *substantial.* "Conservation of force proves as certainly as it proves anything, that all force is substantial. Nothing can be conserved, or preserved, unless it is something that exists, and it seems to be an axiomatic truth that nothing can exist unless it be a substance of some kind. If force in one form is convertible into force of another form, then all force in whatever form it may be exerted is substance, since it is impossible to conceive of the conversion of one thing into another thing, and neither thing be anything substantial. Our inability to take cognizance of the constituents, or corpuscles of a force, is no valid reason to a thoughtful mind why such force should not be regarded as a real substance—as literally and truly an entity, as is the air we breathe."

The two fundamental principles having been ascertained, our acquaintance with the essential nature of the primordial force depends upon the use we make of our positive knowledge of the specific operations of the several forms of force, as now, for the first time, we are enabled to understand and interpret them. Since we are just beginning to appreciate the great law of conservation of force and the great fact of the unity of all the forces, a better reading of physical phenomena is rendered possible. By these data we plainly read that this force is *electric* in its constitution. We claim that the electric theory is a factor in the explanation of all the phenomena.

We are able to perceive that a great celestial battery is in operation, to which the primordial force owes its perpetual development; a battery differing from our own magneto and dynamo-electric batteries only in scale of operation. It has the same essential constitution and *modus operandi.* Quite like the battery of man's construction, the celestial battery requires the co-operation of two elements, either of which, acting independently, is incapable of producing force, but acting in concert, the two develop all known forces of the universe. These two elements which have never yet been adequately associated in the interpretation of the phenomena of gravity, heat, light, &c., are *motion* and *magnetism;* the motions of the celestial spheres, and the magnetic constituent of each celestial sphere. True, the scientific world has vaguely conceived of the development of power through the agency of celestial motions, but it has failed to formulate any *exact philosophy* of the manner in which those motions should develop actual force. Such a philosophy is accessible.

It is known that the earth is a vast magnet, having a magnetic axis nearly corresponding to its geographical axis, and terminating in a *positive,* or northern pole, and in a *negative,* or southern pole. But the earth's inherent magnetic force must remain purely *potential* or *static,* and without the ability to act, or to move, except through the co-operation of a separate and independent force, whereby this static magnetism may be converted into active, vital currents. From our experience with the electric battery, we know that motion, and change of polarity, are capable of producing vital, active force, from force inert and dormant. In the celestial, as in the terrestial battery, motion and change of polarity are pre-requisite to the awakening of inert, dormant force, into vital, active force.

That electricity may be obtained from magnetism by motion, or that magnetism, conjoined with motion, may be made the source of electricity, is well understood. So, by their unceasing rotation the magnetic sun and earth furnish both the needed motions, and the incessant change of polarity, which are requisite to the completion of the celestial battery. Thus, through the medium of revolving celestial armatures, acting upon celestial magnets, *statics* are converted into *dynamics,* on a scale commensurate with the demands of the universe; and that dream of the ages, *perpetual motion,* is found a realised fact in nature.

All space being pure vacuum, distance is virtualy annihilated, and all the spheres are brought relatively into close proximity. Mercury, 37,000,000 of miles from the sun, and Neptune 2,800,000,000 of miles, stand alike in their relation with the great central orb. This condition is thus favourable to such "*action at a distance,*" as is found *indispensable* to the inter-communications going on between the bodies which constitute the universe of matter. The fact of instantaneous action at a distance, and without a medium of transmission, though questioned, is demonstrated in the action of gravity.

Through the operation of the celestial battery a great current of force is incessantly in motion from the sun to the earth. Both the law of conservation and the law of magnetic action demand that a current of equal proportion shall as incessantly return from the earth to the sun—the one current cannot for a moment exist without the other. Were this return current interrupted, the light of the sun would instaneously cease, all life would become extinct, and, the power of cohesion being suspended, the earth and everything thereon would return to their original elements, and vanish into space. In this action, and retro-action, we find a grand magnetic circuit between the earth and sun, through the operation of which the earth's portion of the primordial force is utilised. The same conditions which exist between the sun and earth, as described, exist also between every satellite and its primary, and between the star-suns of the universe.

Solomon was wiser in some respects than the scientists of the present day. He says that "The wind returneth again according to his *circuits.* All the rivers run into the sea, yet the sea is not full; unto the place from whence the rivers come, thither they return again." Science recognises the immense movement of force from the sun to the earth, but has she made sufficient account of the fact that the earth is not full? Has she recognised the fact that back to the sun again, in some form or other, the rivers of energy must return in ceaseless circuit? And yet, the law of conservation demands it, and the electrical theory satisfies the demand.

The various manifestations, or affections, of the primordial force which receive the appellation of the great physical forces have their fullest and clearest explanation through the interpretation given by the electrical theory.

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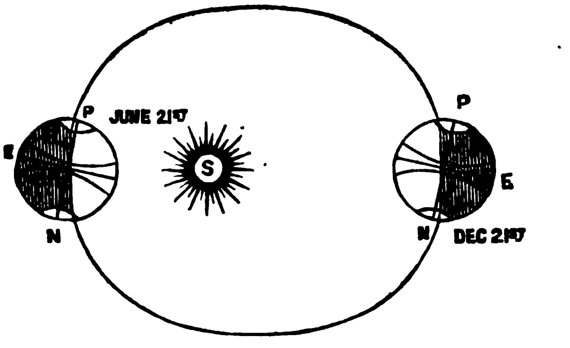
Gravity Considered as an Affection of the Primordial Force.

Science has strangely neglected to examine the field which gives best promise of an ultimately satisfactory explanation of this phenomena.

According to the present popular philosophy, "gravity acts directly as the mass, and inversely as the square of the distance." Faraday says, "The received idea of gravity appears to me to ignore entirely the principle of the conservation of force, and, by the terms of its definition, if taken in an absolute sense, 'varying inversely as the square of the distance' to be in direct opposition to it."

If gravity acts directly as the mass, then surely, as the sun's mass is *constant*, and the earth's mass is also *constant*, the force of attraction should at all times remain invariable, and the earth's orbit should consequently be a true circle, instead of an ellipse. If gravity acts inversely as the square of the distance, then the earth at aphelion could not without the aid of some other force or interfering cause, be returned to perihelion, but the lessening attraction would permit it to move on indefinitely into space.

The electrical theory, however, suggests a more rational, clear, and satisfactory philosophy, and makes provision for the elliptical orbit of the members of the solar system. In order that the earth's orbit, for example, should be elliptical, the mutual attraction existing between the sun and the earth must necessarily increase and diminish with mathematical exactness and regularity. To such *regularly varying attraction*, and to no other cause, can the ellipticity be due. Attraction is greatest about the 21st of December, when the two bodies are nearest each other, and least about the 21st of June, when they are relatively the most distant. Whether the attraction between the sun and earth shall be greater, or shall be less, depends altogether upon their relative position. Thus when the earth's south-pole presents nearest the sun, the attraction between the two bodies is the greatest, and when the earth's north-pole so presents, attraction is least. Why should this variation in position produce such a variation in attraction? In the light of the electrical theory the following explanation is confidently advanced:



On the 21st of December the *positive* sun (S.) and the *negative* south pole of the earth's magnetic axis (N.) are in closest relation to each other, and the north-pole (P.) is out of the field, therefore the opposing conditions, viz.: the *positive* sun, and the *negative* portion of the earth, represented by the south pole, acting in concert, produce attraction between the two bodies, according to the electrical law that *unlikes* attract each other. At that date the centre of the great electric sun current strikes the earth at a point 23½ degrees south of the equatorial line, and from thence moves in the direction of its mass towards, and along the earth's natural magnetic axis; in this instance, towards the north. This northerly movement of the electric mass is *concurrent* with the earth's magnetic axis, and the force of attraction between the two bodies is thereby increased to its maximum.

On the 21st of June precisely opposite conditions exist; the *positive* sun and the *positive* north pole are in closest relation to each other, and the south pole is out of the field; attraction between the two bodies is consequently at that date lessened, and this in accordance with the electrical law that *likes* repel each other. And, too, the centre of the great sun current strikes the earth at a point 23½ degrees north of the equator, and its mass moves in a southerly direction. The direction of this electrical movement is *contrary* to the earth's natural magnetic axis, and the force of attraction between the two bodies is further lessened; consequently at that date they are found at their greatest distance apart, viz., several millions of miles more distant than on the 21st of December.

On the 20th of September, and the 20th of March, the sun is equidistant from the earth's two polar extremities, and the centre of the great sun-current strikes the earth at the equator in a direction at right angles with the earth's magnetic axis. The electrical conditions are thus balanced, and the earth at those periods is equally distant from the sun.

The degree of ellipticity of each planetary orbit is due to the inclination of its axis. If the axis is at right angles with the plane of the ecliptic, the poles must be equidistant from the sun, and attraction and repulsion thus become equalised, and the orbit must necessarily be circular. Had the axis of the earth been perpendicular to the plane of the ecliptic, the sun would always have appeared to move in the equator, the days and nights would have been equal, and there could have been no change in the seasons.

The extent of ellipticity in any orbit is governed by the amount of axial divergence from such right angle.

As a further demonstration of the ability of the electrical theory to account for the grand phenomena of the universe, we will apply it to the philosophy of the earth's axial motions. Electricity and magnetism are regarded by scientists at the present day as virtually identical. The correlation of heat and magnetism is apparently as pronounced, as witness certain natural phenomena which bear directly upon this point. The tropical plant, the *phytolacca electrica*, is known to produce marked electrical effects; a touch of a twig gives to the hand as vivid a shock as that of a Rumkorff battery. At the distance of seven or eight paces the influence of the plant is manifested through a compass needle, the closer the proximity the more marked are the demonstrations; and if the compass is placed in the centre of the bush the movement of attraction previously shown by the needle is changed into that of rapid rotation. The intensity of the phenomena varies with the time of day. At two o'clock p.m. it attains its maximum, and at night its magnetic powers are scarcely perceptible. It is thus demonstrated that at precisely the same hour, viz., two o'clock p.m., *heat* intensity and *magnetic* intensity are *co-incident*. From this hour each diminishes, and from the morning until two o'clock p.m. each increases in the same proportion. The hour of the least magnetic effect or the most *negative* condition is shown by the following phenomenon to occur at a period of time opposite to that of its maximum, or *positive* condition, viz., two o'clock a.m. It is the experience of miners whose lives are passed in the depths of the earth, that between twelve and two o'clock in the night, if there is a loose stone or bit of earth in the mine it is sure to fall. Says a miner of many years' experience: "About this time it seems that everything begins to stir, and soon after twelve o'clock, although the mine has been as still as the tomb before, you will hear particles of rock and dirt come tumbling down, and if there is a caving piece of ground in the mine it is sure to give way."

From these and such like familiar suggestions on the part of nature we may infer that the portion of the earth which is at any given time specially under the action of the great sub-current, becomes *electro-positive*, the maximum intensity occurring at two o'clock p.m. During the night the magnetic condition changes, and is at two o'clock a.m. most *electro-negative*. Thus at two o'clock p.m. the sun on the one hand, and that portion of the earth on the other hand, being in like electrical conditions, viz., *electro-positive*, mutually repel each other, and the consequent *push* moves the earth in revolution. The revolving earth turning eastward, is continually carrying its *negative* condition of the night into the field of the *positive* sun, a mutual attraction therefore takes place with its consequent *pull* upon that side; and thus is generated the process of an incessant attraction on the east side, and of repulsion on the west side, giving to the earth its axial motion.

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Gravity may therefore legitimately be claimed as purely an electrical phenomena.

The words of the grand old Faraday now stand forth in lines of light, viz.: Gravity, surely this force must be capable of an experimental relation to electricity, magnetism, and the other forces, so as to bind it up with them in reciprocal action, and equivalent effect.

Sun Heat, as an Affection of the Great One-Force.

The demonstrations of our senses, as well as the teachings of all the ages, lead us to attribute to the sun the possession of a most dazzling brilliancy, an unlimited amount of heat. So it certainly appears. Yet the simple fact, that the earth receives its heat through the agency of the sun, is not conclusive evidence that the sun is itself hot. On the contrary, it is well known that heat rapidly diminishes in the direction of the sun, and that at the altitude of considerably less than three miles lies the line of perpetual frost, the temperature of space progressively lowering beyond that point. The space, therefore, which separates the earth from the sun, 93,000,000 of miles in extent, is inconceivably cold; its intensity is variously estimated at from *minus* a few hundred degrees (Fahr.) to *minus* 18,000,000 of degrees. It seems incredible that scientists who possess the knowledge of these facts can entertain the thought or attempt to maintain the theory that heat comes from the sun, *as heat*, through such a distance and such a medium. And, if not coming as heat, then the previously existing philosophies of the functions of the sun are *fundamentally erroneous.*

Science at the present time admits of four different explanations of the production of sun heat, viz.,—(1) combustion of cosmical substances falling into the sun; (2) arrest of motion of substances thus supposed to fall into the sun; (3) contraction of the solar mass; and (4.) dissociation of compound bodies in the sun's substance. Each of the foregoing hypotheses stands in direct opposition to the inexorable law of conservation of force. Each recognises the presence of a vast flood of heat, light, and force incessantly issuing from the great solar mass, and proceeding therefrom with inconceivable velocity to the earth. Yet neither of them makes provision for the retro-acting or returning current, which under the law of conservation becomes indispensable. Each assumes the actual and indispensable presence of heat at the sun as an element in the solar economy. But inasmuch as heat cannot come from the sun as *as heat*, there really exists at the sun no necessity for the enormous production there, such as these hypotheses demand. The prodigious destruction of material claimed to be involved in the production of heat at the sun, and the expenditure of an inconceivable amount of force in projecting the same in all directions, and to inconceivable distances into space, are uncalled for, and therefore irrational. Upon the electrical theory, no such extravagant and irrational processes are needful.

A true understanding of the great physical phenomena of our earth depends upon a correct knowledge of the constitution of its atmosphere. There is a more vital element than clouds, vapours, gases. This constituent is magnetic in its character, and may be designated as *static*, from its habit in equilibrium, and also in contradistinction from the vast *active* current which fills the space between the sun and the earth. In all scientific formulæ of its constitution, this principle as a real enity has been ignored. The fact that the atmosphere is a vast magnetic reservoir, that it is the most magnetic of all earthly bodies except iron, nickel, and cobalt, is well understood; yet there appears to have been no suspicion of the grandeur and importance of its functions in the earth's physical economy. As constituted, the atmosphere is peculiarly adapted to co-operate with the sun in this economy.

In fact, it is the medium and instrument of all the sun's terrestrial operations. Prepared by such knowledge of the constitution of the atmosphere, we can better comprehend the philosophy of the action of the great sun-current so incessantly moving earthward.

By means of the dynamo-electric machine, it is demonstrated that motion or magnetism (or both), is converted into heat and light; so does not analogy suggest that the grand motions of the heavenly spheres are by the same principle converted into sunlight, and sun-heat; thus making unnecessary the measureless and ceaseless destruction of material that is demanded by the present theory? Our atmosphere supplies the conditions represented by the "carbon point," and the "platinum coil," in practical electricity. A current invisible, without manifestation, passes through space, as electricity through wires, until, meeting the resistance and favourable conditions of our atmosphere, there occur those wonderful and important phenomena, heat and light. No particle of either heat or light need therefore come as such from the sun to the earth, the current being wholly invisible and cold in its passage. For a practical demonstration of such transmission of a current we are much indebted to experiments made by Prof. Mahlon Loomis, of Washington, D.C. Without any visible means of transmission, he succeeded in sending the magnetic current from one mountain top to another twenty miles distant.

In the light tenuous atmosphere of the summits of lofty mountains the human body often experiences the fiercest effects of sun-heat, and the pyrheliometer of Pouillet also records such effects for the reason that the body and the instrument become *objects of resistance* to the current, and a local heat is thus developed which is far greater than that of the light atmosphere surrounding, which offers no such resistance. It is hardly necessary to add that the greater heat always manifested on the surface of the earth beneath is owing to the fact of a denser medium, and a consequent greater resistance.

The battery of mundane construction—our best aid and interpreter in the reading of universal phenomena—while it is the developer of heat, light, and power, is it itself neither luminous, hot, nor magnetic. To explain the effects of the sun, therefore, there is not the least reason to infer that it is itself luminous, or even warm. Potential action generated in a dark, cold body may produce great heat, light, and attraction, at a distance from the seat of activity, and what is thus wrought artificially, in a small way, may surely be done naturally, and in a tremendous fashion, by the grand forces of the sun.

Sunlight.

The same process develops sunlight. If lines be drawn from the sun to the earth, tangent to both, these lines will enclose a tapering space, the sun at the big end, the earth at the small end, and the space between a truncated cone; this space may be designated the solar cone or cone-space. Within this space incessant circulation is going on, and all the phenomena of gravity, heat, light, are produced through their reciprocal activity. The field of encounter between the forces of the sun and earth is our atmosphere, and in the collision light is generated. Being thus conditioned upon the atmosphere, light and heat cannot be found in space beyond the lines of the solar cone.

It is to be observed that light rapidly diminishes in the direction of the sun, even as we have seen to be the case with heat. Beyond the lower portion of the atmospheric mass there is no dazzle; and the human eye in looking upon the great orb is not dazed. Thus the exceeding brilliancy which characterises the sun's rays, so far from being a phenomenon located in the sun itself, as is the popular, and even the scientific conception, is actually confined to the lower strata of our atmosphere.

If light were transmitted to us from the sun in perfect intensity, the entire vault of heaven must appear as luminous as our sun.

The sun is therefore not the manufacturing place and distributing reservoir of *actual* light and heat; it is rather the source from whence the whole solar system is supplied with the *invisible, potential* light and heat, which become developed where it is required. The great central orb may therefore be regarded as like unto the earth, on its surface, and in its surroundings, viz., a dark, cool, habitable body.

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Other Recognised Forms of Force.

All other recognised forms of force have their best explanation in the same theory.

It may be necessary to caution against a natural misconception which is fruitful in seeming objections against the theory advanced. Let it be understood then, that man's machinery must always work to disadvantage when made to illustrate the operations of nature. The machine itself is an inert thing, a dead weight interposed, the working of which requires the expenditure of force. In nature's operations, on the contrary, without labour or friction, one form of force under proper conditions transmutes itself into another form, there being no loss of force in the change. We must recognise the fact of an unimpaired energy in the universe, the fact that force is never lost nor wasted.

The Great Primordial Force owes its genesis to the initial impulse which set all spheres in motion in vacuous space. To this universal principle, not only all physical force, but new life itself is due.

Humboldt says: "It is indeed a brilliant effort, worthy of the human mind, to comprise in one organic whole the entire science of nature, from the law of gravity to the formative impulse in animated bodies."

That the earth, and the sun, and all the heavenly bodies, are possessed of the mysterious magnetic energy, and consequently exert a powerful magnetic influence over each other, has long ago been conceived by such men as Herschel, Humboldt, Faraday; and is the faith of scientists to-day. But when we have arrived at such a conclusion, it is impossible for us to stop short, and not make the necessary deductions therefrom. Mighty magnets, when involved in mighty motions, must produce mighty currents and mighty effects. It is not for nothing that these powers and conditions exist. If we admit the premises, we must not ignore the conclusions that are necessitated. Provision must be made for the outcome of every admitted fact in science.

Therefore, it is with assurance that we urge the electric theory, and maintain that the burden of proof rests with those who, admitting the elements of motion and magnetism, have yet made no provision whatever for their keeping.

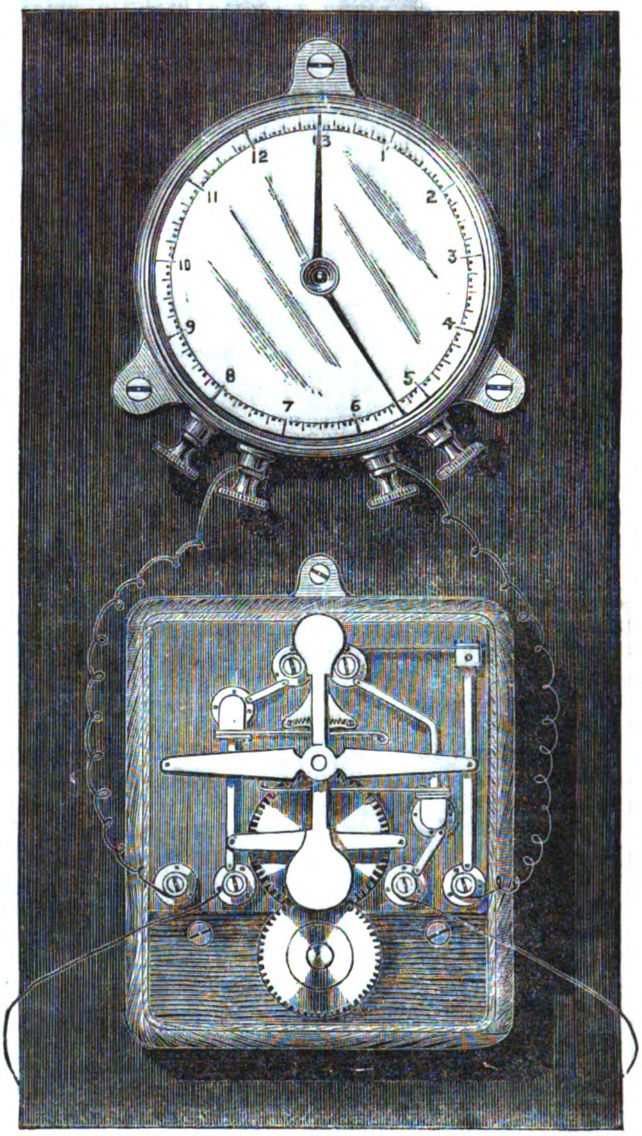
Besides, there are two other principles already alluded to—the conservation of force, and the unity of all the forces—with respect to which it may be demanded, to what other result do they lead, and can they lead, in all reason and logic, than to the admission of the grand fact of a Great Primordial Force.

KEMPE'S ELECTRICAL WATER LEVEL APPARATUS.

The object of this apparatus (which was designed in the first instance for the Nottingham Waterworks Company) is to show at the pumping station the rise or fall of the water level in the reservoir into which the water is being pumped. The arrangement consists essentially of a "transmitter" and an "indicator." To the former (which is fixed at the reservoir) a float is connected, by the rise or fall of which *momentary* currents flow in one direction or the other. The importance of arranging the apparatus to make *momentary* contacts only is evident, otherwise, from the slow rise or fall of the water level, the series of currents would be continuous ones, which would soon cause the battery to be exhausted.

The general appearance of the "transmitter" is shown by the lower of the two figures in diagram. The bottom toothed-wheel is fixed on to the spindle of a drum, around which are wound two metallic cords, one attached to the float, and the other to a counterbalance weight. The movement of the toothed-wheel causes a lever, unequally weighted at its two ends, to be turned round until the heavier end passes just beyond the vertical position, when it topples over, and in so doing makes a momentary contact. The right or left hand movement of the toothed wheel, by means of a peculiar contrivance, causes this momentary current to be on the one direction or the other, according to the direction in which the wheel turns.

The "Indicator," which is seen in the upper part of the figure, has its indicating hand fixed to a toothed wheel, which can be actuated in one direction or the other by two ratchets; one of the latter is worked when a positive current is sent to line, whilst the other is worked by a negative current. These two movements are effected by means of two electro-magnets, provided with a polarised armature between them. This armature is normally held equi-distant between the poles by means of two levers, which are pulled against the two stop pins by springs, but it is free to move either to the right or left when either a positive or a negative current passes through the electro-magnets. The second-hand seen in the figure is merely for the purpose of showing the last indication which the instrument showed at any particular time.



Kempe's Electrical Water Level Apparatus.

The whole apparatus has been found to be of great service, and to work admirably. At Nottingham the entire water service is fitted with the instruments, one indicator being seven miles distant from its transmitter. Besides the indicators in the pumping stations, there is a row of them in the office of the engineer in the town.

Similar instruments are being fitted to the Kent and to the Southport Waterworks; several also are in use in Australia.

A Cable across Lake Superior.—It is under consideration to lay a telegraph cable across Lake Superior, in Canada.

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SPAGNOLETTI'S ELECTRIC FIRE ALARM.

The Exchange Telegraph Company, Messrs. Bright, and Mr. Spagnoletti, each exhibited fire alarms at the late Crystal Palace Exhibition. We now illustrate and describe the apparatus of Mr. Spagnoletti. The inventor of this apparatus being a member of the jury, it was not entered for competition. Fig. 1 shows an older form of sending apparatus.

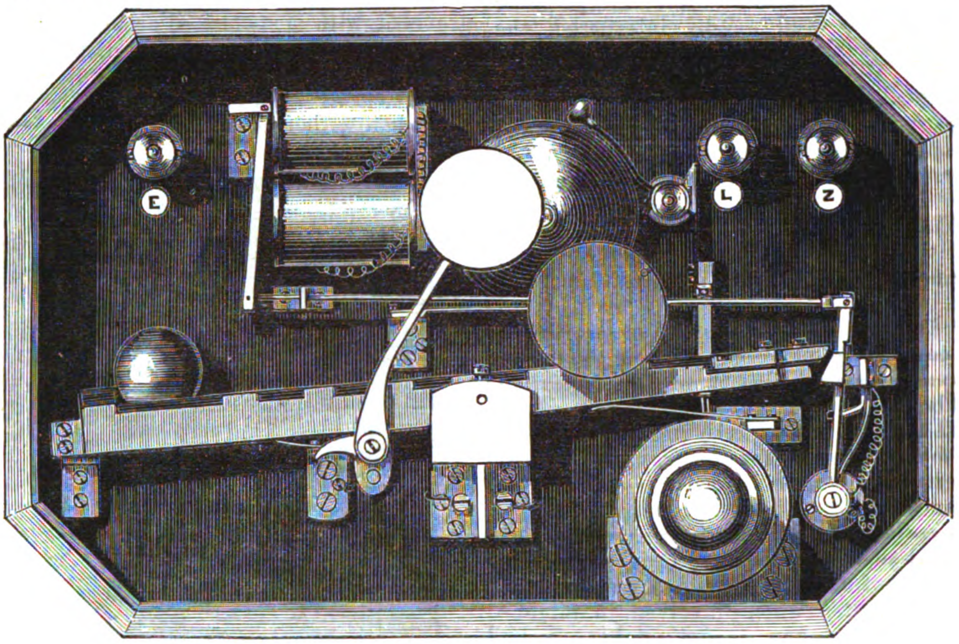

FIG. 2.—Spagnoletti's Fire Alarm, new form.

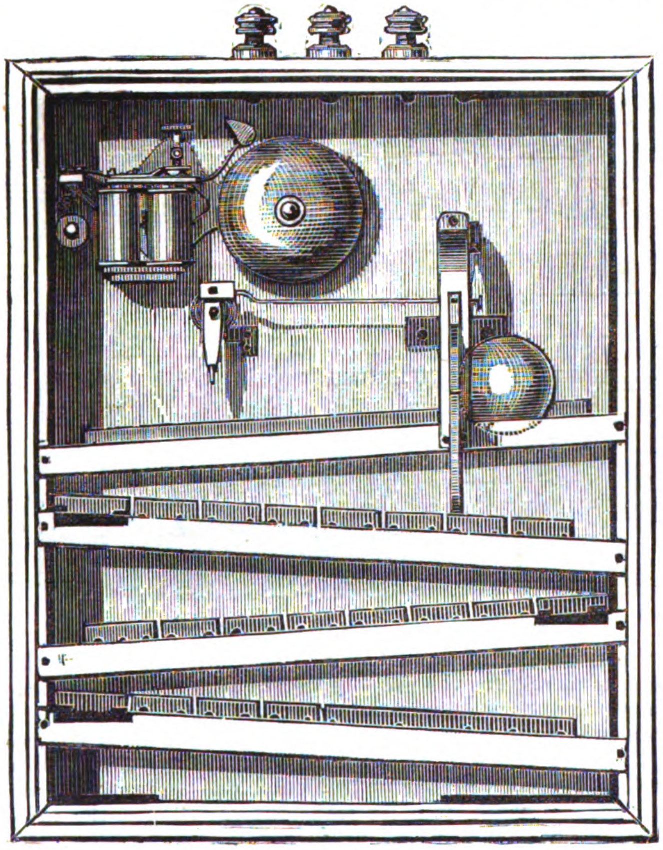

FIG. 1.—Spagnoletti's Fire Alarm, old form.

This system includes a sending and also a receiving instrument. The sending instruments are put up in the streets or rooms, and each has its corresponding connection to the receiving dial. It will be seen that the apparatus consists of several shelves, slightly inclined, down which the ball shown on the upper shelf rolls when released. To send an alarm a little lever is lifted, the ball thus released rolls down the inclined planes, and in its course sends currents of electricity, which act on the pointer of the instrument at the central station, and make it travel round the dial, stopping at and pointing to the printed name of the street or place whence the alarm has been sent. At the same time the ball starts rolling in the transmitter, the bell begins to ring in the receiver, calling attention. This bell continues to ring until everything is set right again, ready for another signal to be sent. The watchman sees at a glance the street or place from whence the alarm is sent, and sends the engine off instantly. He then presses in a small plunger at the foot of the receiving instrument, which resets the pointer to zero, and rings at the same time by the same action the man's bell in the transmitter, to acknowledge the alarm showing it is understood and attended to. The replacing of the ball by the sender of the alarm stops the bell in the central station instrument and deflects the needle of the small dial, thus advising the man at the station that all is in order for another signal to be sent. The ball in the street boxes may be started by the fire-escape men or policemen, and they can reset the ball; but if the instrument is actuated by one of the public, it is better that a man should be specially sent to reset it.

The aim of this system is instant communication, least possibility to derangement, total absence of wheels, clockwork, and springs, chains, winding up, &c., simplicity of working and certainty of action, no waiting while the central station man translates a cypher or has to find out in any other way from whence the signal came before he can despatch the engine. The public cannot tamper with the sending apparatus, for when once the ball is released it rolls to the end of its course and sends the signal showing where it came from.

An improved sending apparatus is shown in Fig. 2. It is contained in an iron box, painted, and which may be fixed upon posts or placed in the wall. There is a small pane of glass over the handle and directions to "pull the bell." In this apparatus we have a rocking way working on a pivot, with one end heavier than the other. On pulling the handle a bell strikes, and the end of the rocking way is caught under the catch. The ball runs down, making on its way a number of contacts—the number varying with its position—and stops at the end. When in this position the ball joins up the releasing magnet, so that when an acknowledgment is sent from the central station the current passes through the coils of the magnet, the armature is attracted, and being connected, as shown, to the catch, moves it away, allowing the rocker to resume its original position. The ball rolls back, but makes no contacts in so doing, and the apparatus resumes

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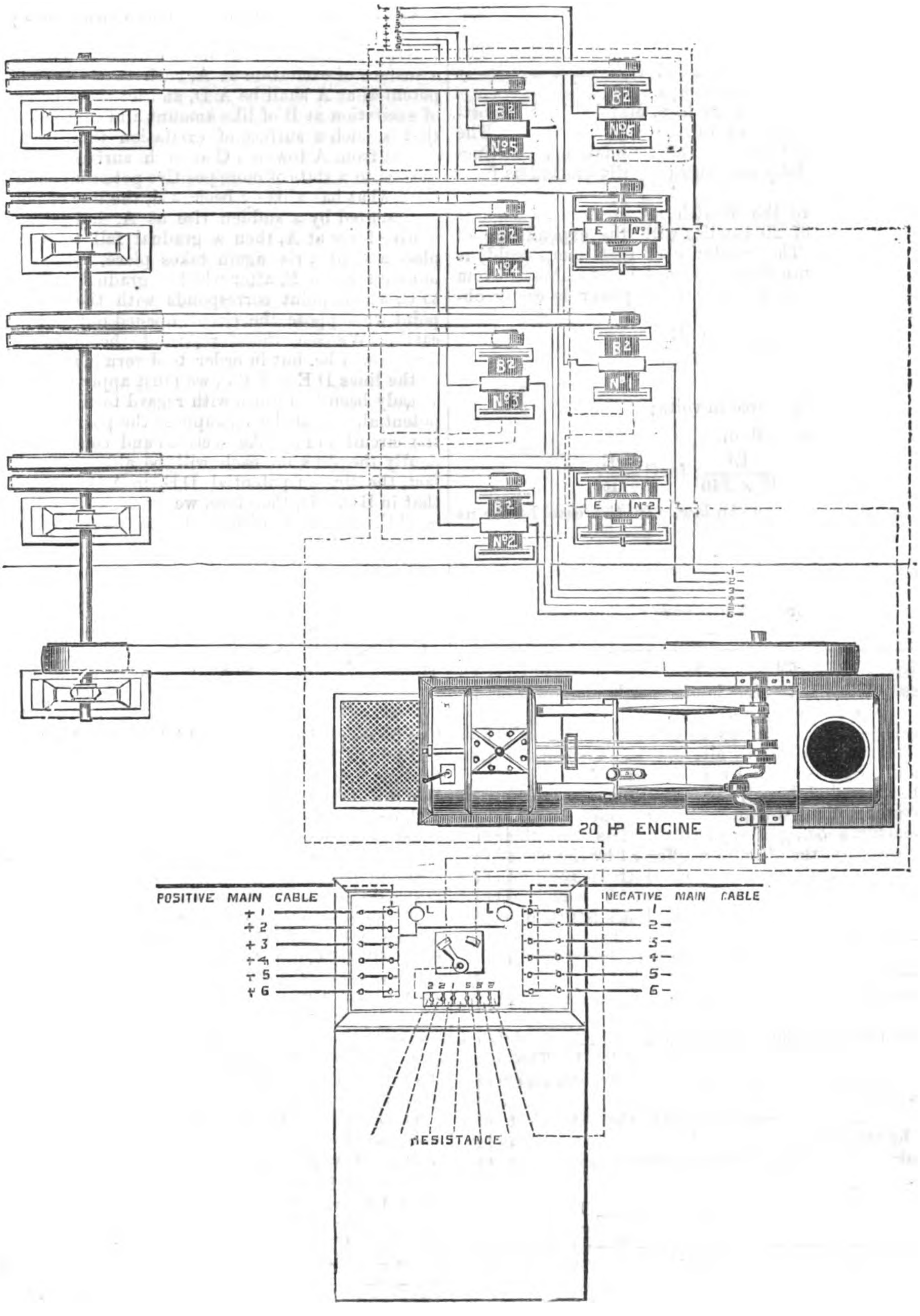
its normal condition, and is ready for another signal. There are two discs—a red one, which always shows except when the handle is pulled to give the signal, when a white one comes before it, but is thrown back again by the acknowledgment of the signal from the central station. The figures, we think, clearly show the working of the apparatus.

THE LIGHTING OF STAFFORD HOUSE.



FEEDING CIRCUIT SHOWN THUS — — —

MAIN " " " ——

In our issue of June 24 we referred to the introduction of the electric light into Stafford House. Previous to this installation the British Electric Light Company had lighted Trentham Hall, in Staffordshire, to the entire satisfaction of the Duke of Sutherland, who determined to introduce the light into his town residence. We herewith give a plan of

the arrangements adopted. The work was completed in about five weeks from the date of the order. The number of lights in use is about 300. Thus, at the concert on June 30, there were in the banqueting room 73, in the picture gallery 228, in the machine and engine room 9, or a total of 310 lamps. The current for the lamps is obtained from six B^2 Gramme machines, with two E Gramme feed machines. One of the E Gramme's only is in action, the other being kept in reserve, so that should any accident happen to the one at work the second is immediately switched on. The change can be so rapidly accomplished that there is scarcely any variation in the light of the lamps.

The steam engine used is a 20 h.-p. Marshall's semi-portable, which is placed adjacent to the machine room. The latter is a wooden structure, but the foundations, shafting, and plant are as carefully and substantially erected as for a permanent station.

The lamps used are the British incandescent. Each is said to give a light of 20 candles with the expenditure of one ampere current. The resistance of each lamp (cold) is 150 ohms, the resistance (hot) is from 80 to 83 ohms. From these data the candle-power per horse-power is easily obtained. Thus

$$\text{H.-P.} = \frac{C\,E}{746}$$

when C = current in amperes,

E = electromotive force in volts;

or the formula may be written,

$$\text{H.-P.} = \frac{E^2}{R \times 746};\ \text{for}\ C = \frac{E}{R}$$

according to Ohm's well-known law. In the case before us the value of C = 1 and E = 80 to 83, say 80.

$$\therefore \text{ each lamp absorbs } \frac{80}{746} \text{ of a horse-power.}$$

Hence the candle-power per horse-power

$$= \frac{746 \times 20}{80} = \frac{746}{4} = 186{\cdot}5.$$

This comes practically to nine lamps per horse-power of 20 candles, or 180 candles per horse-power.

The regulation of the lamps at their proper standard of illumination is maintained by altering the resistance in the feed circuit. This is done by means of a series of plugs fitted on to the switch board, the indications of the extent of alteration being given by means of two pilot lamps. The dynamo machines being always run at less than their full generative capacity, the alteration effected by the use of one or more of the resistance plugs at once increases or diminishes the main current to the extent required. The resistance of the armature of the B^2 Gramme machines is 0·4 ohm, the resistance of the magnets 1·5 ohm. The electromotive force at 1,000 revolutions per minute with an external resistance of main circuit and lamps of 0·3 ohm is 150 volts. The main conductor is a cable composed of 19 strands of No. 12 B.W.G. copper wire.

In the fitting up of these lamps the gilt brass candelabra previously used for wax candles was utilised. The work altogether reflects great credit on the company, and its success is due in a great measure to the energy of their engineer, the Hon. R. Brougham. It may be stated that the electrolier exhibited by the British Electric Light Company at the late Crystal Palace Exhibition is now suspended from the central lanthorn of the picture gallery at Stafford House.

Electric Light for Hastings.—The Town Council have, after some consideration, accepted the offer of the Hastings and St. Leonards Electric Light Company to supply 35 Brush lamps for one year at £750, this sum to include posts, lamps, wires, attendance, &c., and the lighting for 3,600 hours per year, provided that half the lights are extinguished each night at 11 o'clock. The council have also given the Company power to lay down wires, &c., for private lighting in addition to the public lamps.

THE (ELECTRIC) CONDUCTIVE AND INDUCTIVE CIRCUITS GEOMETRICALLY ILLUSTRATED.

BY F. C. WEBB, M.I.C.E.

(CONTINUED FROM PAGE 155.)

We have hitherto only supposed a single surface of excitation or electromotive force in the circuit.

Let us now consider the case of a circuit containing two or more surfaces of excitation.

Suppose A B (Fig. 12) to be one portion of a circuit having a surface of excitation at A, such that the sudden change of potential at A shall be A D, and let there be another surface of excitation at B of like amount and in the same direction; that is, such a surface of excitation that, tracing along the circuit from A towards C at each surface, a sudden rise or change to a state of more positive potential shall occur. Then, from what has already been said, the line of potential will be represented by a sudden rise at A, indicating the electromotive force at A, then a gradual fall towards B, at which place a sudden rise again takes place, indicating the electromotive force at B, after which a gradual fall will take place to C, which point corresponds with the point A, at which point we suppose the circuit opened out and in contact with earth. We see, therefore, what the general form of the figures will be, but in order to determine the exact position of the lines D E and F C, we must apply the laws which have already been laid down with regard to the dips of the lines of potential. First, let us suppose the portions A B and B C of the circuit are of like sections and conductivites, then evidently the dips on each will be alike in each part, or, in fact, the line of potential D E, in A B, must be parallel to that in B C. If, therefore, we erect at A a line A K = A D + E F, or, in fact, a line equal to the sum of the electromo-

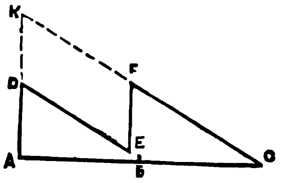


Fig. 12.

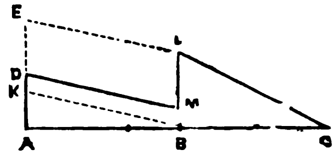


Fig. 13.

tive forces of the circuit, and join K C and cut off F E = D K and join D E, we shall obtain the figure A D E F C, showing the complete state of the potential throughout the circuit. For E F = D K, D E is parallel to K F, and consequently to F C, or the dips of the lines of potential in the two parts are equal as required, and, as we have also placed the sudden rises in potential at the extremities of the parts in their required position, *i.e.*, joining the line of potential of one part with that of the next, the figure is wholly determined.

If the circuit is composed of parts which are not of like section and conductivity, then the distribution of the potentials will be found by dividing the sum of all the electromotive forces of the circuit into the same number of portions as there are different parts in the circuit, making these portions directly proportional to the length of the parts and inversely proportional to the products of their conductivities and sections. Then these portions will give in succession the total amount of fall which must be assigned to the line of potential in each part of the circuit respectively.

Thus, suppose A B (Fig. 13) a part of a circuit, and B C another of equal length and material, and of half the section of A B. And let there be an electromotive force equal to A D at A, and a similar electromotive force at B. Then A E (= 2 A D) equals and represents the sum of the electromotive forces in the circuit. Now we have to divide this line A E into two parts, which shall be to one another directly as the lengths of the parts A B and A C, and inversely as their sections, or, in fact proportional to

$$\frac{A\,B}{1} \text{ and } \frac{B\,C}{2}.$$

We must, therefore, divide A E into two parts (at K), one of which shall be one-third of the whole line, and will give the total amount the line of potential must fall in the length A B, and the other (or K E) two-thirds of the whole line A E

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the amount of the line of tension must fall in B C. Consequently, if we join K B, and draw D M parallel to K B, D M will be the line of potential in A B, and K E is the amount the line of potential must fall in B C; therefore, making B L = K E, and joining L C, we obtain L C for the line of potential in B C, and it will be seen that as K B is parallel to D M, and D E = M, that M L = D E = the electromotive force at B, thus fulfilling all the required conditions.

Other examples of the determinations of the lines of potential in such cases might be given, but this subject is not enlarged on because it will be seen in what is about to follow that a more simple method of dealing with all problems relating to the voltaic circuit can be obtained. We have hitherto represented always the *absolute* lengths of the different parts of a circuit, and have made the dips of the lines of potential vary inversely as the products of the conductivities and sections of the several parts; but if we now represent the several parts of the circuit by lines which shall be at once directly proportional to the absolute lengths of those parts, and inversely proportional to the products of their conductivities and sections, and give the line of potential the *same inclination* or dip throughout the circuit, we shall still give the potential correctly at each part of the circuit, and we shall find a far easier manner of representing all problems relating to the potentials in the circuit.

This, in fact, is nothing more than representing what Ohm terms the "reduced lengths" of the different parts of the circuit, or what is now more generally termed the "resistances" of the several parts of the circuit instead of representing their absolute lengths.

Thus, if l = absolute length of a conductor
S = section
c = specific conductivity
R = its absolute resistance or reduced length.

Then $$R = \frac{l}{S\,c}$$

To show the difference of this mode of projecting problems of the voltaic circuit with that I have hitherto given, let us take the same case as that given in Fig. 13, viz., a circuit having two electromotive forces, and composed of two parts of equal length, A B and B C, but having different sections, that of B C being half that of A B.

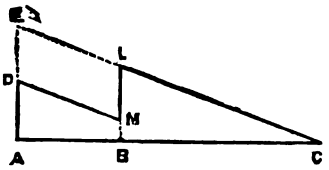

Fig. 14.

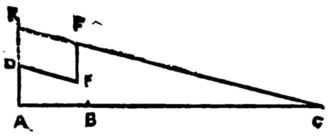

Fig. 15.

Then, since B C (Fig. 14) has half the section of A B, it has twice the reduced length; B C must, therefore, be drawn twice the length of A B. If A D is the electromotive force at A, A E equal to 2 A D = the sum of the electromotive forces in the circuit.

Join E C and draw D M parallel to E C, cutting the perpendicular B L at M. Then must L M = D E, and we obtain the figure A D M L C for the entire figure.

In the same way if B C (Fig. 15) has half the section and also half the conductivity, we must make B C four times the length of A B, and the line of potential will be A D F F′ C.

Before we proceed further it will be well to give a few examples of the properties of circuits by this means. Suppose we wish to represent the line of potential in a battery of five similar elements of Daniell, of which the zinc is connected to earth and the copper to a line, having a resistance equal to twice the whole resistance of the battery, and connected to earth at its distant end. Let A B represent the electromotive force of one of these elements, and A D the resistance of one element. Then twenty times A D (or A C) will be the entire resistance of the circuit, and five times A B (or A E) will be the sum of all the electromotive forces in the circuit, and joining E C we get E C for the inclination of the lines of potential (Fig. 16).

To obtain the complete figure, we must cut off on the line A C the portion D D′ = to A D, which will represent the resistance of the second cell, and in the same way D′ D″, D″ D‴, and D‴ K will represent the resistances of the other three cells. Consequently, D, D′, D″, and D‴ will give the position of the 2nd, 3rd, 4th, and 5th zincs, and, consequently, the sudden changes of potential representing the electromotive forces at the surfaces of junction of these zincs with the liquid will be situated somewhere on the perpendiculars D F, D′ F′, D″ F″, and D‴ F‴. And to obtain the position of the electromotive forces on these lines we must divide A E into five equal parts at B, B′, B″, and B‴. Then, drawing B L parallel to E C, and cutting D F at L, we obtain B L for the line of potential in the first cell, and in the same way B′ N, cutting D F at L and D′ F′ at O, we obtain N O for the line of potential in the second cell, and we also get thus L N for the electromotive force of the second cell. In the same way the whole figure, A B L N O P, &c., may be obtained, giving the potential at every part of the circuit, K M being the potential at the copper pole of the battery.

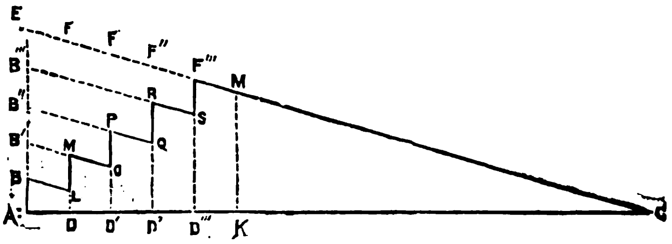

Fig. 6.

If the liquids in the cells of the battery, being all of the same nature, have different lengths (that is different distances between the zinc and copper plates), or have different sections (that is have plates of different sizes), then the reduced lengths of these cells will have different lengths, whilst, if the elements be of precisely similar nature in other respects, their electromotive forces will still be all equal. Thus, a pair of plates, A, separated to twice the distance of another pair, B, similar in size, will have twice the resistance of the pair B. And a pair of plates, C, separated the same distance as the pair B, but having double the surface of the pair B, will have half the resistance of B.

The Edison System in France.—The Edison Company have now completed the establishment of a factory for the manufacture of their dynamos, lamps, &c., in Paris. Owing to the laws of the country it was absolutely necessary to establish a factory where everything appertaining to the system could be manufactured, as if any foreign article is imported into France and sold, the patents obtained for it become void in that country. This obstacle to the introduction of the Edison system has now, however, been surmounted, and we are informed that several plants are being laid down in different parts of the country. The factory, as established, consists of three principal departments: First, the machine works, where the dynamo machines, resistance boxes for the regulation of the magnetic field, together with all the necessary lamp fixtures are made. Second, the lamp factory, which consists of the glass department, where all the glass part of the lamp is made; the fibre room, where the fibres are cut and finished, which when carbonised make the carbons for the lamp; the clamp room, where the clamps which hold the carbons in the lamp are made; the plating room, where the carbons are plated on to the clamp, so as to insure good contact; the pump room, where the air is exhausted from the globes; and, lastly, the testing room, where all lamps are tested and marked. Third, the electric tube works, where all the underground mains are made, together with the junction boxes, safety boxes, &c. The lamp factory at present has a capacity for turning out 1,000 lamps per day. There are over 300 men employed at the works. Mr. Batchelor is manager, and is assisted in the machine works by Mr. D. Cunningham, who was master mechanic at the Edison machine works in New York.

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CITY AND GUILDS INSTITUTE.

The fourth annual report of the City and Guilds of London Institute is now before us, showing the results of technological examinations held in the spring of this present year. To the steady progress made in the numbers of candidates examined the report bears ample testimony; and on the whole the examiners speak hopefully of the advance made in the quality of the instruction obtained by the candidates who offer themselves for examination. Considering the very short period during which this praiseworthy scheme of the City and Guilds of London has been in operation, there is much reason for congratulation. No fewer than 3,467 students were attending technical classes according to returns received down to November last, and the numbers are rapidly increasing. These figures are, perhaps, the best criteria of the interest felt in technical instruction, and the hold it is taking upon the industrial part of the community. The spread of knowledge requisite for the improvement of our manufacturing industries is the one great aim of the patrons of this Institute, and it matters little how many persons submit themselves for examination so long as the instruction is everywhere of a solid and satisfactory kind. At the rate of progress now being maintained, it is evident that in a few years' time the technical education of our artisans will bear comparison with the vast manufacturing interests with which this country is so conspicuously identified.

The students, however, who have the courage or the ambition to let their schooling be tested by competent examiners are rapidly increasing. In 1881 the numbers were 1,563, whilst for the present year they reached 1,972. The centres of examination—in other words, the area of instruction—increased from 115 in 1881 to 147 in the present year. The report modestly speaks of these figures as satisfactory; to our thinking, they could hardly be regarded as other than most encouraging. Speaking broadly of the results of the examinations, the same observation holds good. Out of the 1,972 students tested, 1,222 succeeded in passing; last year only 895 passed out of 1,563. It is obvious, therefore, that not only are the technical classes augmenting in numbers, but that the efficiency of the teaching is improving. The palm in this respect is, as usual, carried off by a few great manufacturing towns; partly on that account, but apparently also because of the existence of some local institute of exceptional excellence. Only in this way can we account for the important, but by no means the largest of our manufacturing towns, namely, Bolton, furnishing by far the greatest number of successful candidates. A certain Church institute at that place seems to be doing wonderful service in the way of technical education. Glasgow comes next to Bolton, Manchester and Bradford are a long way behind, and Birmingham—is nowhere. Perhaps the arts for which Brummagem is celebrated do not require, and would perhaps be spoiled by the cultivation of scientific accuracy. At Sheffield, too, there is, if this report may be taken to represent the thirst for technical knowledge at that place, a very poor display—the one solitary training establishment noted in the list being a board school. Here perhaps a remark let fall in the report may afford an explanation of some otherwise unaccountable anomalies. "The difficulty," says the report, "which still exists of finding competent teachers prevents the formation of technical classes in many places where such classes are greatly needed, and consequently retards the more rapid increase of candidates for these examinations."

Turning specially to those items of the report which relate to technical instruction comprehended under the head of Electrical Engineering, we are confronted with figures, which if not alarming are by no means enlivening. Of the actual number of persons attending classes of this kind we have no precise information; but the number going up for examination is far below our expectations. Electric lighting and transmission of power was new to the programme; but it is not a new subject, and that only 36 candidates offered themselves for examination is not particularly flattering to this revived branch of scientific industry. Only 27 of these succeeded in passing, and for the most part only in the ordinary or pass grade. On this point we cannot help remarking upon the circumstance that the lecturer at one of the principal institutes appears to have been the examiner in the subject of his lectures. It strikes us that the two functions, if not incompatible, are to say the least of it, incongruous.

For telegraphy, the number of candidates examined fell off from 99 last year to only 60 in 1882. Of these 46 succeeded in passing, the remaining 14 being failures. Even of the successful candidates, only 34 were new students, the other 12, or one fourth of the whole number, going up for higher honours. There is no gainsaying the significance of these

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figures, and to those who hoped and expected that the study of scientific telegraphy would spread with the increase in the number of telegraphists they will be grievously disappointing. Several large centres of telegraphy, which furnished respectable contingents of competent students last year, are now conspicuously blank. Various explanations will, of course, be offered of this remarkable falling off, one of which, taken in connection with the recent troubles in the postal telegraph service, is so obvious that it is not worth commenting upon. On the other hand, the metropolis, which has cut a very poor figure on previous occasions, comes off more creditably on this. The chief honours, as was to be expected, were taken by the Cowper-street Institute, but the seven pupils sent up from the school at the Central Telegraph Station all obtained pass certificates. This school, we are told, is doing excellent work in directions apart from the technical scheme now under consideration, many of its pupils preferring to go up for the Science and Art Department, South Kensington, examination.

Neither Mr. Preece nor Mr. Ayrton, the examiners respectively in telegraphy and electric lighting, speak in complimentary terms of the bulk of the papers submitted to them. The first-named gentleman complains of the mechanical character of the answers and the absence of a knowledge of broad principles, while the latter echoes the remarks of the report on the evident difficulties of obtaining competent teachers. This difficulty is, indeed, one which, unless speedily overcome, will seriously impede the work of every scheme for the advancement of technical education, and we are glad to see that the committee are keenly alive to the danger. Technical training colleges are, in reality, more needed than technical classes. This, however, is a work of time, and meanwhile the nation has much reason to be grateful for the admirable work which the city of London has so liberally endowed and so energetically pushed forward.

CORRESPONDENCE.

ELECTROMANIA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: To the admirable remarks by Mr. Mattieu Williams I would like to add the following remarks:—

Now Mr. Mattieu Williams, although he strikes at the root of so much "incorporated" nonsense, does not go far enough. In the page I have torn from an American periodical and enclosed, you will note that there is this statement:—"The company assume that no efficient system of arc, or incandescent lighting, or of the storage of electricity in secondary batteries, can be worked by any outside company without infringing fundamental patents held by the Gramme Association." Now, Mr. M. Williams assumes a much weaker position than is his by right, for these patented old inventions are claimed by the new patentees to be "fundamental." It would be an interesting inquiry to learn (1) in what way these patents are "fundamental," and (2) how this monopoly can be maintained.

The fundamental principle of all *dynamo* machines, that of mutual accumulation, is historically due to either Sinsteden or Hjorth. On this point we have the endorsement of Du Moncel.

The "shunt-circuit" dynamo was first described by Wheatstone. The authority here is C. W. Siemens.

The collector or commutator now used very frequently in dynamo machines—in fact, by nearly all makers—is one of these fundamental inventions; and according to Aug. Guerout [*La Lumière Electrique*, July 1st, 1882] this is inferior in construction and the same in principle as that used by the Italian Professor Pacinotti.

The form of the induced ring is a matter for more careful consideration than is usually bestowed upon it. That Pacinotti invented *a* ring armature there is no doubt, but he did not invent *the* Gramme ring armature. His armature had iron projections, or teeth; Gramme's has a continuity of surface on the iron of the ring. The investigation by Du Moncel of the actions of the electro-magnetic field upon the De Meritens armature, and his researches into the magnetic condition of the Gramme armature, show these actions and conditions to be much more complicated in the one case than the other. So far as the continuous-surface ring is concerned, the Gramme patent is, then, a fundamental one; but that this is not necessary to an efficient dynamo machine is proved by the fact that the machine most largely used at the present day, and backed by the greatest number of incorporated bodies representing the largest amount of electric light capital, has for its armature a Pacinotti ring modified in no important manner.

Now, as to these "fundamental" claims and their value. There is no doubt whatsoever that any one possessing the requisite knowledge can make a dynamo machine, and as efficient an one as exists. He would take a Pacinotti ring armature with projections, which he would set in a proper magnetic field, and collect his currents from a Pacinotti or a Dove commutator; and he could connect it up on either the direct or the "shunt" circuit principle, and without infringing any one's patent in any country whatsoever. Therefore, the cheapest and most efficient machine will probably be that least burdened with associations and patent rights, for the reason that it will best bear competition. This may not be pleasant news to shareholders in certain companies, but I challenge any one to contest the truth of my statement. We have, therefore, as Mr. Williams says, to look to future improvements for our value, unless inventors are willing to be content with less than a monopoly, and compete in a true commercial fashion. There is no reason why this should not be; telegraph cables are not made under patents, nor are gas companies formed, as a rule, to exploit them, yet there is no sounder stock in the market than that of these two classes of industrial corporations.

In fact these electrical *quasi*-monopolies can only be sustained by expensive injunctions at law, and by the fear of incurring these injunctions if one starts in manufacture, or even buys, in some cases, a competing machine. Under some circumstances it is even possible for a friendly case in court to be got up, granting to the apparent victor the *fiat* of that Court. A good many English patentees so find their inventions (electrical and otherwise) "controlled" abroad. Thus is it done. A has invented something similar to B; B arranges with A to indulge him at court by not a full statement of A's case; B gains the day, and gives A a license and a share of the plunder (if any). But the patent "has been contested," and the fictitious rights have an immediately greater value; by their position capital is alarmed that C's rights *may* infringe. The only cure for this complaint would be the judge's power to subpœna expert testimony for his own information.

I have not infringed on Mr. Williams's special subject of lamps. But I think arc-lighting will be found cheap enough when lamps are sold for less than five to 10 times their cost of manufacture.

In the matter of storage batteries the inventor has more hope and more scope.—Yours &c., PAGET HIGGS.

DYNAMO-ELECTRIC MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the description of a dynamo-electric machine, given by Mr. St. George Lane-Fox, in his paper which appears in *The Electrician* of July 29 last, he says in explanation of the production of the current of electricity by the revolution of a coil of wire across a magnetic field "no electricity is generated, the electricity is already in the wire."

May I ask him or any other expert to be good enough to

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explain this a little more. I and other students quite understand what he says so far, but how the supply of electricity is kept up is what we would like to have explained.

The current, we are told, is set up in opposite directions in the coil, and flows away for whatever purpose it may be required; but will he kindly tell us where does the fresh supply come from so soon as the small amount of electricity inherent originally in the coil has passed away?—Yours, &c.,

A STUDENT.

Sturford, Warminster, 9th August, 1882.

TELEGRAPHIC COMMUNICATION WITH THE EAST.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I call your attention to what two very great authorities have to say about a submarine line to India *viâ* Ascension and St. Helena?

See letters to *The Times*, August 5, 1882.

Dr. C. W. SIEMENS.	Sir JAMES ANDERSON.
The cable would be situated in deep water throughout nearly its whole length, where, according to our present knowledge of telegraphic engineering, it would be much more securely placed than in shallow water, and could in case of need be picked up with almost the same facility.	No one with any knowledge of telegraph cables will dispute that these proposed lines, laid in the deepest part of the ocean, could be cut as easily as cables submerged in moderate depths, and as the trade winds prevail steadily in the same direction along three-fourths of the proposed link, repairs would at all times be a long, tedious, and expensive operation, even if practicable at any time.

Which of these two statements are we to believe?—Yours, &c.,

H——G.

Bank Holiday, August, 1882.

FIRE RISKS FROM ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Thanks to Mr. Phillips for the assumption that I am "content with demolishing the work of such a strong committee of electricians." If I could flatter myself that I had done so I should do what I still am doing—that is, preparing to follow up my attack by offering various suggestions for preventing fire risks and other failures by more effective precautions than are contained in the "Rules" in question. Meanwhile, the omission he points out was not an oversight, but being noticed as an omission I may as well point out that, in counting the cost of some of the restrictions that Mr. Heaphy, for example, specifies in reference to rather problematical contingencies, it is surprising that neither he nor any other surveyor has objected to the ordinary electric bell in places where an escape of gas could easily occur, when the ringing of such bell in an explosive atmosphere would cause certain explosion. This may be proved with the greatest ease and certainty. But a short circuiting "trembling bell" reduces the risk at least twenty times. In reference to the "barely possible occurrence," as Mr. Phillips puts it, I refer him to Mr. Haywood's report on the lighting of a section of the city of London by the Brush Company, as published in *The Electrician* of July 29. That report, taken in conjunction with the sentence in the preamble to the rules by the Society of T. E. and E., referring to the electrolytic corrosion of the conductors, will bear out my assertion. But how will this sort of explanation (or defence) suit your other correspondent, "Electric Light?" My meaning is, perhaps, to him, wrapped up in such "involved language" that he would again "give it up;" but, after all, he did not read my letter several times, as he says, for nothing. He found a mare's nest and makes good fun out of it. I am not proud of the sentence introducing "Eureka," but the drift of it is intelligible enough, and I need not assume that "Electric Light," or other of your readers are ignorant of the meaning and general English use of the word that "Electric Light"—being evidently a funny man—tries to make a handle of to ridicule what he cannot controvert. (He will find nominative case in its right place, thanks for "E— L—'s" inquiry.)

Whether "Electric Light" thinks it or not, many others, whose monied interests and best wishes are centred in electric lighting, will think as I do, that of all the blows struck at it by various antagonists the "Rules" put forward by professedly its best friends will prove to be "the unkindest cut of all."

A more damning charge against the practicability of electric lighting on a large scale I cannot imagine than the *nota bene* after Rule 17, and I say again that, admitting that it is easy to test the wires frequently, "I fail to derive much consolation from the fact, either in view of the consumer's pocket or the reputation of the electrician."

For if electricians, individually or collectively, insist on the necessity of frequently testing the wires, a considerable expense for repairs and renewal of wires must be reckoned on, besides the expense of the testing, and if the consumer's pocket is to be drawn upon so much as this implies I should not envy the reputation of the electrician who would sanction such a system.

If "Electric Light" when he began to read my letter expected to find something to bolster up the "Rules" in question, he was, indeed, "signally disappointed," and if he is, or was, one of the committee, or the brother, or the sister, or the cousin, or the aunt of one, I forgive, if not excuse, his stupid imputation of motive. Thanks for the hint, I do not want *pupils*. All the pupils I ever had I paid handsomely to do as I told them, and if "Electric Light" wants to fix electric light wires that will require no testing, I can send him one of my pupils who never saw an insulated wire before working for me.

"Electric Light," apparently in good faith, apologises for the committee for doing what they ought not to have done, and for leaving undone what they ought to have done, and in doing so uses my criticism with such grotesque inaccuracy that what follows seems more ironical than *bonâ fide*. These are his words:—"Again, the omissions complained of—such as that omission of directions how to make the soldering of a joint sound, the best material for capping wires, &c.—are, I think, obviously intentional, as it was no part of the duty of the committee to put into their rules suggestions which might easily be construed into hard and fast rules by too zealous inspectors."

Now, instead of complaining about the omission of such details, I, from the first reading of the rules, looked at the one in question about the joints as such a ridiculous attempt at *precision* that it was and is impossible to look leniently on the crude ideas embodied in the other rules. In fact, precise instructions are set forth about a matter that telegraph linemen know more about than the committee, whilst other more important details that the scientific electrician ought to throw light upon are summed up in vague generalities. The other omission "Electric Light" refers to about "the best material for capping wires" is a different matter. But I did not say a word about such omission. I did not enlarge about the various methods of wire insulation, although the committee are emphatic about "efficient insulation," yet give no advice how to do it; and "Electric Light" thinks the reason is that their rules might easily be construed into *hard and fast* rules by too zealous inspectors.

I could write much on the subject, either in *The Electrician* or other medium, but am in no great haste to do so. If "Electric Light," or any other, speaks first that which wants saying, I shall be glad to be their echo only, for on several vital points of this question the truth must sound so strange that I care not to court the distinction of the great honour, or the great enmity, not even for "a handsome new Eureka" from "Electric Light."—Yours, &c.,

W. MOSELEY.

[We print but a portion of Mr. Moseley's letter. The charge might, perhaps, be justly made that "Electric Light's" letter was somewhat outside of the discussion of facts. A little laughing now and then is, however, admissible; but our

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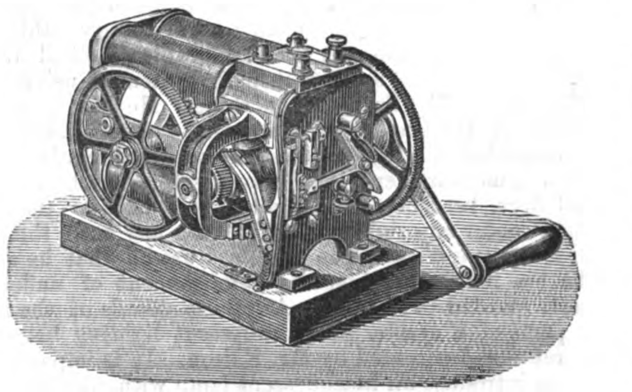
space is not sufficiently free to do more than admit very short letters on verbal criticisms. Mr. Moseley has made a sweeping condemnation of the rules. It lies with him to prove such condemnation justifiable.—Ed. *E.*]

DYNAMO ELECTRIC EXPLODER.

This machine, which has been adopted by the Federal Swiss Army, is of a sufficient power to easily fire 30 fuses arranged in series at a distance of 500 kilometres. It will fire by induction as well as by incandescence. When the line is not too long it suffices to lay a naked wire on the ground, when the return of the current is effected by the ground itself.

The machine is constructed according to demand, either for being worked by pulling a cord wound round the spindle of the induction cylinder, or by turning a handle communicating with this cylinder by means of gearing.

When in use the apparatus is protected by a box of hard wood, the only parts seen being the binding screws and the end of the spindle by which the machine is actuated.



The Bürgin Electric Exploder.

The machine consists of four electro-magnets, forming together a single horseshoe electro-magnet. Between their poles turns the induction cylinder, formed of soft iron bobbins, arranged in heliocentric succession, perpendicular to the axis of rotation.

The circuit is closed immediately the current is developed. An armature is attracted by the poles of the fixed magnets, and by its movement sharply interrupts the direct current, which, augmented by the extra current formed in the bobbins, and by the discharge of a condenser, sends with great force a current through the exterior circuit containing the mine fuses. These exploders, as well as the Bürgin lamp described by us last week, can be obtained from Messrs. R. E. Crompton and Co.

The Telegraph Train for Egypt.—A daily contemporary says:—The red-coated Engineers, who are usually employed by the Post Office in the repair and extension of the telegraph wires throughout the country, left London for the seat of war on Wednesday, in the troopship "Oxenholme," having been recalled from their various wanderings, and reformed into C Troop Royal Engineers at Aldershot. From thence they marched, with their waggons and equipment, on Saturday, as far as Egham, and on Monday they reached Regent's Park, within an easy stage of the docks in which their ship was prepared. They take with them an "air line" of 200 miles in length, and a "cable section" with 20 miles of strongly-bound wire, for a ground line, to convey orders to distant divisions of the army during an engagement. The air line will be stretched on slight poles, of which a vast number are carried. The officer in command of the Telegraph Troop is Major Sir A. Mackworth, and the other officers are Lieutenants Hippesley, Foster, Bond, and Anstruther, and Surgeon G. P. Turner.

SWAN OR EDISON IN AMERICA.

The following statement of the case between Swan and Edison as concerns America is taken from a report on the Swan lamp patents originally prepared for the instruction of the Edison Electric Light Company's agents. We have no doubt Mr. Swan is quite prepared with an answer. However this may be, we would, remembering the work done by the rival claimants, say, Is the question worth wasting one penny over in litigation? No legal tribunal will deal with aught but the validity of patents, and yet we make bold to say that in a few years the question of patents will be altogether forgotten. The report runs thus:—

Mr. Joseph Wilson Swan, of England, after whom the "Swan Lamp" is named, has only two patents in the United States relating to incandescent electric lamps. The first, No. 233,445, was applied for April 12th, 1880, and granted October 19th, 1880; the second, No. 234,345, was applied for June 16th, 1880, and granted November 9th, 1880. These are the only patents on the "Swan Lamp" in the United States.

Before stating what these patents cover, let us see what they do not cover. In that regard, Mr. Swan's own admissions are important. In his specification filed when he applied for his first patent (No. 233,445), he says, "My invention relates to that kind of electric lamp in which light is produced by the incandescence of a continuous conductor of carbon enclosed in an exhausted glass bulb, and provides means for increasing the durability of the said kind of lamp." Just what is meant by this statement prepared by Mr. Swan himself should be carefully noted. What does he mean?

First. Swan does not claim himself to have invented an "electric lamp," but merely to have invented "means for increasing the durability" of one. In other words, he claims only an improvement on an existing lamp.

Second. The "kind of lamp" which his invention "relates to," was one which he found in existence when he undertook to improve it; one, he says, "in which light is produced by the incandescence of a continuous conductor of carbon enclosed in an exhausted glass bulb." That is to say, Mr. Swan found such a lamp in existence, and he tried to improve it.

Third. This description of an electric lamp which Mr. Swan undertook to improve is an exact description of the Edison incandescent lamp, on which a patent was allowed to Mr. Edison in the United States, December 19th, 1879, and issued to him (No. 223,898) January 27th, 1880, several months before Mr. Swan even filed his application for his first patent. This patent thus granted to Edison was for an "electric lamp for giving light by incandescence," by means of "carbon filaments" enclosed in a "receiver made entirely of glass from which the air is exhausted," which is exactly the lamp referred to and described by Mr. Swan, at a later date, in his patent.

Thus it appears that Mr. Swan himself disclaims to have invented an incandescent electric lamp, and that all he claims to cover by his patents (this is true of his second patent as well as his first) are merely minor points of mechanical detail, being merely alleged improvements in the durability of an incandescent lamp already in existence.

Let us now see just what these alleged inventions claimed by Mr. Swan amount to. His first patent (No. 233,445) has four claims, viz., first, platinum caps connected to both the glass and the leading-in wires, second, the carbon loop or horseshoe formed from a straight strip of parchment paper bent into shape, third, the carbon made of parchment paper, and, fourth, coating the leading-in wires and caps with glass or enamel. His second patent (No. 234,345), contains two claims: first, parchmentising thread prior to its carbonisation, and, second, making enlarged ends therein by wrapping material therearound and cementing the wrapped material by parchmentisation.

Are these alleged inventions, admitting that they are such, of any value? Let us consider them in order.

In Swan's first patent the first claim is for platinum caps uniting the glass and leading-in wires. Mr. Edison uses the

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platinum leading-in wires, but omits the cap. Mr. Swan claims that the use of the platinum cap is an improvement on Mr. Edison's method, because a better contact may be made between the platinum and the glass. The fact is, Edison early tried both ways, and the result of his experiments was that the contact was just as good in one case as in the other, and that the omission of the platinum cap, which alone costs nearly as much as Edison's entire lamp as now manufactured, was an important step towards economy. Besides that, if the small platinum leading-in wires will not make a reliable union with the glass, surely Swan's increase of the platinum surface will not remedy the defect. If there be any defect in such union in the one case, it will still exist even to a greater extent in the other.

The second claim in Mr. Swan's first patent is for a straight strip of paper bent into a loop or horseshoe. This was the form first used by Edison, and probably by every other experimenter on lamps. But Edison improved upon it. His improvement consists of cutting the paper into shape, instead of bending it, it being evident to any one that by cutting paper into exact shape greater uniformity of result can be attained than by bending, and no special care or work is needed in ensuring that all loops shall be uniform.

The third point in Swan's first patent, and the first point of his second patent, is parchmentisation prior to carbonisation. Edison tested this as early as 1878, and he soon after mentioned it in a caveat, but he found no gain in this additional step of parchmentisation. Besides, it cost money, and increased the cost of production of the finished lamp.

The fourth claim in Swan's first patent is coating the leading-in wires and caps with glass or enamel. This is to avoid the difficulty arising from "occluded gases." Mr. Edison long ago dispensed with the use of this coating, and states that it is an unnecessary trouble and expense. He makes his lamps without it, and yet finds no difficulty from "occluded gases." The use of the coating, claimed by Mr. Swan to be an improvement, unnecessarily increases the cost of the lamp, and shows that somewhere in the lamp something has not been properly provided for and done, or, in other words, that there has been poor workmanship.

The only remaining point in the Swan patents is making the enlarged ends by wrapping. This is neither so cheap, effective, nor simple as the later plan invented by and now used by Mr. Edison, namely, simply striking out or cutting the carbon with its enlarged ends homogeneous with the body. By the latter there are no additional steps, while by the Swan plan there is an additional step, requiring tedious and delicate manipulation, adding to the cost.

It thus appears that Mr. Swan's so-called improvements on parts of the incandescent lamp are, commercially speaking, of little value. Every point claimed by Swan is something discarded by Edison in his march towards simplification, which means the best result and the best service for the least money.

Having thus shown what the alleged inventions in the two Swan patents amount to, let us see whether Mr. Swan has a good title even to what he claims.

Upon the second and third points in his first patent Swan is already in interference in the Patent Office with both Edison and Maxim. On such points, Swan being a foreigner, the earliest date of invention which under the law he will be permitted to prove, is either the date of filing his application in this country, viz., April 12th, 1880, or the date of his earliest foreign publication, namely, his English patent of July 20th, 1880. Both Edison and Maxim, in their preliminary statements, set up dates long anterior to Swan's earliest legal dates in this country, and there can be no doubt that one or the other will prevail against him and receive the valid patent on these points. As to his second patent, applied for June 16th, 1880, which is the earliest date of invention our law assigns to him, being a foreign inventor, as against a citizen inventor, Mr. Edison attacks him on the broad grounds of making enlarged ends by wrapping around the end of the carbons. This invention was not only made, but was publicly mentioned by Mr. Edison long before Mr. Swan's earliest date of June 16th, 1880. Indeed, it was even described in one of Mr. Edison's patents (Edison's Canadian patent No. 11,520) filed before that date. There can be no doubt, therefore, that Edison will prevail against Swan on this point. Thus of the few things claimed by Swan in his two patents, it is certain he cannot hold two of them, and it is probable, for reasons which should not now be divulged, that he cannot hold any. But even if he could hold them all, Mr. Edison would be entirely unaffected, because Mr. Swan's patents are simply for matters of detail, and Mr. Edison has long since abandoned them for better methods. Swan covers nothing Edison uses, and what Swan covers Edison has left behind.

Thus it appears, with regard to the Swan patents, first, that they do not cover an electric lamp, and contain no broad or fundamental principles, but are matters of mere mechanical detail; second, with reference to a part of the alleged inventions embraced in the patents, Swan is in interference with two other inventors, and there is every reason to believe he will be defeated; third, that the art of making an incandescent lamp has advanced so far since Swan's alleged inventions were made as to make them obsolete; and, fourth, even if they were not obsolete, they add so much to the cost of labour and material, they are practically worthless.

But it must be remembered that even if Mr. Swan's patents were for a lamp instead of for a few details of one, and even if those details were important instead of being worthless, his patents would still amount to nothing unless he had also invented and patented a comprehensive system of using them. In this respect Mr. Swan has nothing. He has no patents whatever on any system or on any of the almost innumerable details needed in a lighting system, involving regulation, distribution, measurement, conductors, safety catches, meters, chandeliers, brackets, drop lights, &c.; nor do the Swan patents confer any right on him to use any such things, or even to make a lamp. The slightest use of what he alleges to be his inventions involves infringement of underlying patents granted to another. All these details of the necessary parts of a system of incandescent lighting have been elaborated and patented by Mr. Edison. It is impossible to make or introduce an incandescent lamp without them.

In this connection, a concise statement should be made of Mr. Edison's patents, including his fundamental patents on an electric lamp, his patents on methods of manufacturing a lamp and mechanical details, together with his large number of patents on the important details of a system of incandescent lighting. The fundamental patents, which give Edison a monopoly of the incandescent lamp, are as follows, namely, No. 223,898, dated January 27th, 1880; No. 227,229, dated May 4th, 1880; and No. 230,255, dated July 20th, 1880. Besides these, Mr. Edison has 34 other patents already granted in this country on the lamp alone, and has applications for 56 more patents on the lamp alone now awaiting decision. In these patents, and especially in the first three above named, the following points are broadly covered to Mr. Edison:—

1. An electric lamp having a continuous conductor (without regard to its material, resistance, or mode of preparation) and an exhausted glass enclosing globe.

2. An electric lamp having a continuous carbon conductor (irrespective of its material, resistance or mode of preparation) and an exhausted glass enclosing globe.

3. A filament of carbon of high resistance secured to metallic conductors (*i.e.*, the leading-in wires).

4. The method of manufacture, *i.e.*, first, separately forming the enclosing globe and the support for the carbon, and then affixing the carbon upon the latter, uniting the globe and support and then exhausting.

The broad principles covered in the above-named fundamental patents allowed to Mr. Edison are so exclusive that it is not too much to say that neither Swan nor any one else has made or can make a successful incandescent lamp without infringing every one of the above patents.

But these patents allowed to Mr. Edison on his lamp are only a small portion of the patents allowed to him in connection with the use of the lamp. Up to the present time no less than 109 patents have been allowed Mr. Edison in the United States alone on his lamp and on the details connected with its manufacture and use, and he also has 104 addi-

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tional applications for patents on the same subject now awaiting examination at the Patent Office. These patents cover such subjects as the lamp, regulators, dynamos, meters, motors, conductors, underground mains, junction boxes, sockets, chandeliers, brackets, and many other devices, altogether constituting a complete and perfect *system* of electric lighting. The whole subject of the Swan patents in the United States may be summed up as follows :—

1. Mr. Edison is an original inventor of a new type or genus of lamp. Mr. Swan does not claim to be such an inventor, and claims only to have made improvements of detail in such a class or genus. Indeed, Swan disclaims the inventorship of the class or genus.

2. This new type or genus of lamp is patented broadly to Mr. Edison.

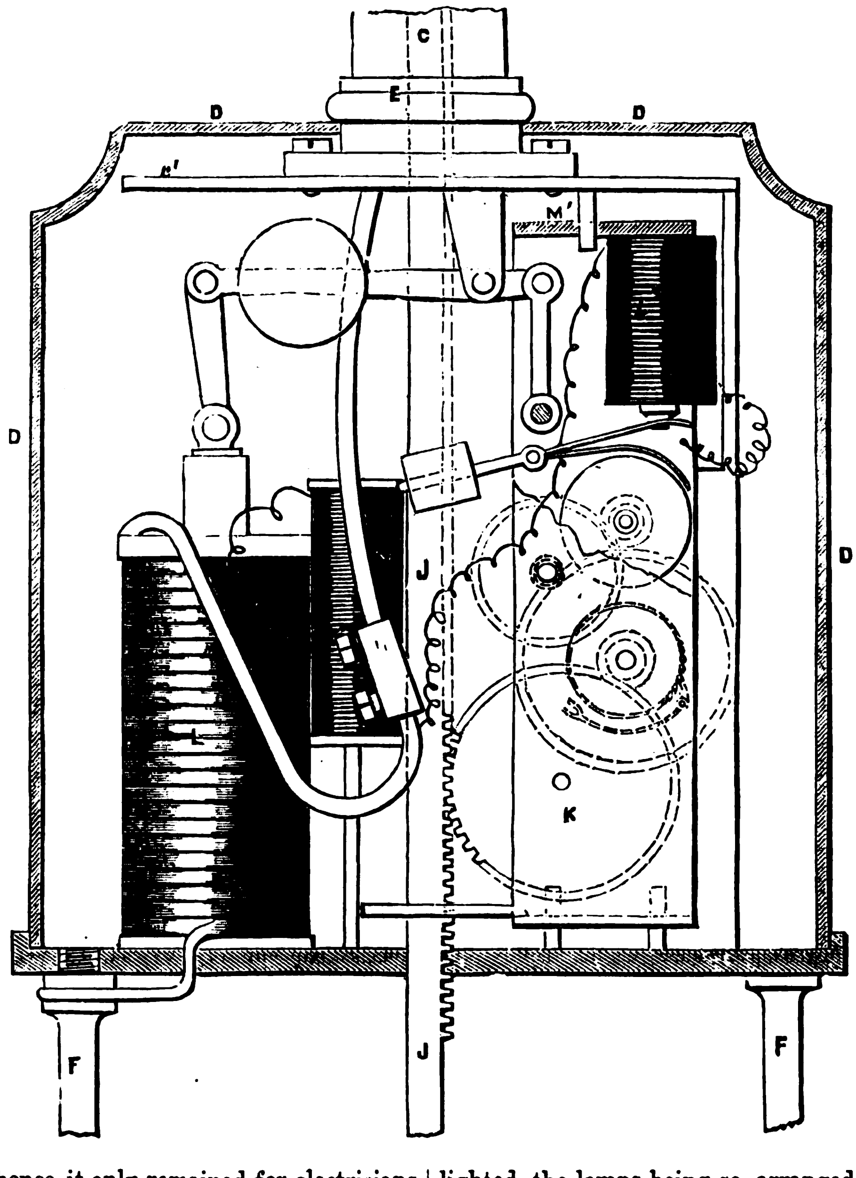
3. All that Mr. Swan claims are only some minor features of alleged improvements, but it is doubtful if they really are improvements, *all* of them having been tried and discarded by Edison, for simpler and more economical means equally or more efficient for the ends sought, long before Mr. Swan's patents were issued.

4. Mr. Swan's title to some of the points or improvements he even does claim is in litigation. If he prevails in the litigation, he cannot injure Mr. Edison, as Mr. Edison uses none of the points in controversy. Nor could Swan even then make and use a lamp, for he must infringe, in using his own alleged inventions, several prior fundamental patents previously issued to Edison.

The Swan lamp has not yet been manufactured or sold in this country. Until that is done, or some other overt act is committed constituting an infringement, no legal proceedings against the Swan lamp can be begun.

THE ELECTRIC LIGHT AT THE "DAILY TELEGRAPH."

The political Press now-a-days spares neither men nor money in the effort to give the latest and the best information. If a new discovery seems likely to help the work in any way it is adopted, hence it only remained for electricians to show the possibility of the electric light for it to be adopted to facilitate the work of the Press. The installation of the light in printing offices has commenced, and we have no doubt will rapidly increase. We recently received an invitation to see the Fyfe-Main lamps at the offices of the *Daily Telegraph* in Fleet-street. On the occasion of our visit, although prior to the usual time for lighting the whole of the lamps, they were all lighted, and so far as we could judge, burned well. The machine room was admirably lighted, the lamps being so arranged as to give no shadows. We shall, however, enter into but few details of the installation, as in all probability the number of lamps in use will soon be considerably extended. There seems to be a great similarity between the Fyfe-Main lamps and the Crompton lamps, as shown at Paris and the Crystal Palace. The accompanying figure shows the most important part of the



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lamp. The action is briefly as follows:—A rack supporting the upper carbon holder has a spur wheel gearing into it which forms part of a train of wheels terminating in a fly, so that the weight of the carbon and carbon holder causes the spur wheel to rotate, and, by means of the train of wheels, to multiply speed so that the fly revolves very quickly. On the axis of the fly is a wheel having a comparatively smooth periphery, which is a brake surface, and there is an electro-magnet which actuates the brake and checks the rotation of the wheels, and, consequently, the further descent of the carbon and holder. The train of wheels and electro-magnet are secured to a cage or movable framework, so that it is free to be raised and lowered by the main electro-magnet, which will attract the core on the one side of the lever and raise the case containing the train of wheels and the upper carbon holder, and so establish the arc.

Referring to the illustration, D is a cover which is capable of being raised to admit of any adjustment being made. It is firmly secured to the base of the lamp by a screw collar E working on threads formed on the lever part of the tube, containing the rack J, which carries the upper carbon holder, and thereby prevents the cover from being removed, except when it has been unscrewed.

The electro-magnet h^4 raises the brake on the upper wheel of the train shown, and allows the carbon holder to descend. A stop is provided on a standard forming part of the main frame, just below h^4 in the figure, which meets the brake only when the cage K is allowed to descend to its lowest point by the cessation of the current in the electro-magnet L, whereby the brake is released and the upper carbon and holder free to run down until it meets the lower carbon in readiness for re-lighting. Two pegs are provided below the cage K, which serve to guide it, whilst the bracket shown to the left of these embraces the rack or carbon holder. The cage is suspended by a link from one end of a lever, which is connected to the core of the electro-magnet L. It is also fitted with a counter-weight, as shown.

The electro-magnet L is in the main circuit, and when the current is passing it attracts its core and raises the cage K, and with it the rack, thereby establishing the arc. The electro-magnet h^4, for actuating the brake, is in a shunt circuit, one end of the wire being connected to the cage K and the other to one end of a resistance coil, M, the other end of which is connected to a binding screw in the main circuit for bridging the arc.

One wheel of the train is provided with ratchet teeth, as shown, and a pawl engages with these teeth when the rack or holder is descending, but it allows of the said rack being raised without actuating the whole train of wheels when it is necessary to insert a fresh carbon.

When the resistance of the arc exceeds that of the electro-magnet L and resistance coil, sufficient current passes through to excite the magnet h^4, which gradually releases the brake, and the rack will then descend by its own weight until the resistance of the arc is again less than that of the shunt circuit, when the magnet h^4 becomes inactive, and the brake is applied to prevent the further descent of the rack.

A shunt (forming part of the branch circuit) is provided to avoid any accident which might occur in the lamp, by means of which the current is directed so as to bridge the arc.

Electric Light at Covent Garden Theatre.—The usual promenade concerts at this theatre have been resumed for this season. Many parts of the house are lighted by Brush lights, thirty-two lamps being used altogether. The large chandelier in the concert room is lit by a combination of electric light and gas. The current is supplied by two 16-light Brush dynamos, driven by one of Fowler's 20 h.-p. compound engines. The lights on the stage, which is fitted up as a Spanish market place, are supplied with tinted globes, and shed a subdued and mellow light, suited to the Moorish character of the scene. The work has been carried out by the Metropolitan Brush Company, under the superintendence of Mr. Reginald J. Jones and Mr. Arnot, electricians to the company.

THE ELECTRIC LIGHTING BILL.

This Bill came before the House of Lords on Thursday week for second reading. We take the following report of the debate on the Bill from *The Times*, for August 4:—

Lord Sudeley, in moving the second reading of this Bill, said that in 1879 a Select Committee went very thoroughly into the whole question of electric lighting, and this Bill was based on their report. Since then there had been a very great development of electricity; but there was no doubt that electric power was still in its experimental stage; and it was desirable that facilities should be given to companies or private individuals to carry on experiments in the simplest and cheapest manner. The leading features of that Bill were—first, that it would prevent any monopoly growing up against the interest of the consumers; and next that it would provide for the making of experiments. Power was given by the Bill to the Board of Trade to grant licenses to companies and private individuals for a period of five years, such licenses only to be granted with the concurrence of the local authority. In the interest of the general public it was desirable that the process of obtaining licenses should be simple and cheap. If the companies had to go before Parliament, and to incur an expense of £10,000 or £20,000, the whole question of electricity was likely to be hung up for years. The undertakers, on applying to the Board of Trade, would have to show that they had a good case, and that the character of their scheme was good. The Board of Trade would institute an inquiry, and, with the concurrence of the local authority, would grant a license. The measure further provided that at the end of fifteen years it should be open to the local authority to purchase the plant and machinery of the company on fair and reasonable terms, the basis of the purchase being the actual value of the existing plant without compensation for future profit. The price to be given for the undertaking was to be the fair market value, to be ascertained in the manner sketched out in the Bill, without goodwill; it would be the fair market price less depreciation—such a price as would be obtained by the company if they were selling to another company without goodwill, and with a reasonable allowance for wear and tear. In regard to the period of 15 years, it should be remembered that, in the case of a patentee, the monopoly was given for fourteen years only, but the present Bill gave one year beyond that time. A precedent for this provision had been laid down in the Tramways Act, although in that case the period was 21 years. Clause 16 afforded protection to the public by providing that persons who were supplied with electricity should be supplied on the same terms. It was also provided that the consumers should have power to use what form of lamp they liked in the same way as in the case of gas. The main objection to the Bill came from the gas companies, who naturally opposed electricity, and did not, of course, like a rival. The gas companies did not in so many words say that they objected to electricity; their objection was to the system of licenses, by which they feared that they would be gradually ousted from the field. The reply to that was that the gas companies had no monopoly in lighting. That was specially laid down by the Committee of 1879, and again by the Select Committee which sat the other day. If the gas companies were allowed to oppose those licenses it was clear what would be the result. Persons wishing to supply electricity would have to apply for powers to Parliament at a cost of £10,000 or £20,000; and they could hardly do that. The Select Committee which sat the other day were of opinion that if the proposed licenses were done away with, and if the introduction of electricity were thrown upon the gas companies it would be highly detrimental to the public interest.

Lord Emly regretted that a Bill of such importance should come before their lordships at so late a period of the Session, when it was impossible for it to receive the advantage of the deliberations of a Select Committee. It was natural that it should be opposed by gas companies, but he failed to see what *locus standi* they had for their objections, any more than the stage coach companies when railways were first introduced. The great difficulty in the Bill was, of course, the twenty-seventh—the purchase clause. A committee of their lordships' House had reported that every facility should be given to the extension of electric lighting. From the nature of the case all operations in that direction must, for some time to come, be experimental. So much uncertainty still obscured many important questions connected with electricity—for instance, its capability of being stored, its generation by water power and so forth—that it was impossible that any undertaking could be immediately successful. Under these circumstances, it seemed to him that a power of purchase exerciseable by the local authorities after five years—that is, at the time

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when the undertaking would become profitable—was likely to deter any person from embarking on any scheme contemplated by the Bill.

The Earl of CRAWFORD and BALCARRES pointed out that the Bill gave their lordships power to take from any individual, within six months of the expiration of the five years referred to in the Bill, the whole of his undertaking. It was true that he was to receive what was termed a fair valuation for it, but it was very well known that when machinery was once laid down it instantly depreciated as much as 50 per cent. He did not wish to oppose the second reading, as the subject was one which greatly interested the public, no less than 9,000,000 sterling of public money having been invested in undertakings of this character; but he felt that the clause enabling the local authorities to purchase, at the mere cost of the plant, the profits of a successful undertaking, without giving anything for the goodwill, could not fail to be a serious hindrance to any attempts to extend electric lighting.

The Earl of CAMPERDOWN failed to see that any just objection could be taken to the 27th clause. What they desired to do was to avoid the creation of one of those large monopolies which had been found so detrimental to the public interests in the past. Nothing of the character of confiscation was contemplated. The term confiscation could only be applied to existing property belonging to existing persons. In the present case there was neither the one nor the other. Again, no objection could fairly be brought against the limit of time fixed in the Bill. It had been found in practice that tramway companies were perfectly contented to take leases extending from fifteen to twenty-one years without demanding terms in perpetuity. It was very desirable that the lighting of towns should be done by the local authorities, and the ratepayers thus saved the great expense they were put to by the gas companies coming to Parliament for further powers.

Earl CAIRNS said this clause was a most material part of the Bill. The noble earl had said that many objections had been raised to it on behalf of the gas companies; that might be so; but the observations he was going to make were foreign to any question which might interest the gas companies. The noble earl said that all that was intended was to grant a fifteen years' lease, and that every one knew what a fifteen years' lease was. But there were very few instances of Parliament having granted a fifteen years' lease, such as was now proposed. It was not a very good principle, and they were not armed with such a quantity of precedents as the noble earl seemed to think. The science of electricity was still in its infancy. If they desired to encourage the development of the science, they must hold out reasonable inducements for that purpose. But what inducements did such a Bill as this hold out? A certain time was fixed during which the exclusive right was given to a body of pesons to light by electricity; but, no matter what expense they might be put to, at the end of that time their plant and machinery were to be bought at a valuation—most probably at very little more than the price of old metal. The noble lord who had introduced the Bill said the clause had been approved of by the committee, but he himself did not read the resolution as expressing approval of it. The local authority was to purchase only the "undertaking," which was a word of art, meaning trade or business. The noble earl had said it was not intended that the undertaking should be bought as a going concern. Then why not say so in so many words? Instead of that, it was to be bought at so much for the plant and fixtures. He thought that no impediment should be placed in the way of the development of this science. The best course seemed to be to allow the Bill to proceed, and to let this clause stand over to next Session for further consideration. He could not imagine anything more momentous in the interests of electricity than the effects of this clause.

The Earl of KIMBERLEY said the important question was, did the terms of this Bill offer a sufficient encouragement to the electric light companies to come forward? In the first place, they had no practical experience at present to guide them; nor was it possible to fix any precise limit as to profits. In this Bill there was no limitation of profits. There had been an attempt by Act of Parliament in the case of the gas companies to check the monopoly by a limitation of profits. The case of tramway companies was a precedent for the proposition that a lease might be granted for 21 years to a company, and that at the end of that period the undertaking might be sold to the local authority. He agreed that they ought to be cautious, though cautious in the interests of the public. If ultimately it should be thought desirable to extend the powers of these companies, that might be done by further legislation. At present this was a mere experiment, the object being to avoid the dangerous monopoly which had been given to gas and water companies. With regard to the resolution of the committee he did not agree that the Bill failed to carry the resolution into effect. It appeared to him, on the contrary, that Clause 27 gave full effect to that resolution, the word "undertaking" being expressly used in the clause. In his opinion there was much to be said in favour of the Bill as it stood, and he hoped the point that had been brought before the House would receive full consideration.

The Marquis of SALISBURY said that the noble earl had referred to the limitation of profits in the case of the gas and water companies. But there was no analogy between that and compulsory purchase.

The Earl of KIMBERLEY pointed out that the clause was passed as it stood by the Committee.

The Marquis of SALISBURY said the attention of the Committee could hardly have been called to the effect of the words they had employed. He thought that the terms offered to the electric companies were not quite fair. Moreover, the interests of the public had to be considered, and it was certainly to their interests that the enormous power of the system should be developed as rapidly as possible. The noble earl opposite talked about going to Parliament next year. But they all knew the difficulty that existed in bringing any legislative undertaking to completion.

The Lord CHANCELLOR said he heard with some little surprise the suggestion of his noble and learned friend that the Bill should be passed, leaving out the Purchase Clause. It was most necessary that it should be known what the terms of purchase were to be. He thought that he could reassure his noble friends by stating some facts which were in the possession of the Government. There was no wish to discourage the enterprise in any way, but, at the same time, they were anxious not to repeat the fatal errors which were made in the cases of the gas and water companies. It might be satisfactory to know that not only had all the companies expressed themselves satisfied with the Bill, but also that the Board of Trade had information that one company alone, when the Bill passed, would make as many as 95 applications under it. It must be remembered that the Bill contained no limitation as to profit, and he thought that the term of fifteen years would give the companies a tolerably certain prospect of a good harvest being made.

Earl FORTESCUE thought that if they erred at all they should err on the side of precaution.

Lord TRURO said that this Bill was not intended to diminish in any way the profits of the electric lighting companies.

Lord ELLENBOROUGH said that it should be remembered that these companies would have to compete with gas companies, who already possessed very extensive powers.

The Bill was read a second time.

The Bill came before the House of Lords again on Tuesday, 8th August, for the third time. The following is *The Times'* report of the debate:—

Lord SUDELEY said before this Bill went into committee it would be to the convenience of their lordships if he stated at once that since the second reading of the Bill the Board of Trade had very carefully considered again the objections raised by the electric companies on Clause 3 and Clause 27. The Board of Trade had always felt it was difficult to say exactly what was the precise number of years which should be given to a license, and after what exact number of years the local authorities should have power to purchase. The object had been to fix the shortest time for the existence of the monopoly that would be consistent with sufficient inducement for the investment of the necessary capital. After hearing the difficulties which the electric companies felt, mainly on the ground that the installations would be on a far larger scale than was at first thought practicable, the Board of Trade had thought that, in the interests of the general public the term of license should be extended to seven years, and the term of purchase to 21 years. The exact amendments would be as proposed by the noble earl (Lord Crawford). It was understood that this would meet all the objections of the electric light companies, and it was far better, in the opinion of the Board of Trade, that the question should be settled permanently than be allowed to be raised at some future time. The amendment about to be moved by the noble lord (Lord Bramwell) was totally inconsistent with this arrangement, and altered the terms of purchase and could not be agreed to.

Their lordships then went into committee on the Bill.

In Clause 3, on the motion of the Earl of CRAWFORD, an amendment was adopted extending the period of a Board of Trade license from five to seven years.

In Clause 27, the Earl of CRAWFORD moved that the period after which the local authorities may purchase the undertaking of electric lighting companies should be extended from 15 to 21 years, and afterwards at every subsequent period of seven, instead of five years.

The motion was agreed to and the Bill, as amended, passed through committee.

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ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).

The ordinary general half-yearly meeting of the proprietors in this Company was held on the 4th inst., at the City Terminus Hotel, under the presidency of the Right Hon. Viscount Monck.

The SECRETARY (Mr. T. H. Wells) read the notice convening the meeting, and the minutes of the last ordinary and extraordinary general meetings, which were approved by the present meeting and signed as correct.

The report of the directors, which has appeared in *The Electrician*, was taken as read.

The CHAIRMAN said: It now becomes my duty to offer a few observations in moving that the report be adopted. Gentlemen, it will be in your recollection that at our last half-yearly meeting we were engaged in a competition with the telegraph company formed in America, and known by the name of Mr. Jay Gould's Company. You are also aware that at an extraordinary general meeting, the minutes of which were just read, held subsequently to the half-yearly meeting, we passed resolutions confirming an agreement with that company, which brings us into a state of harmony and and working with them. Well, gentlemen, I merely allude to that fact because it prevents me from doing what I generally do at those half-yearly meetings—instituting a comparison between the receipts accrued to us during the past half year, and the receipts of the previous half years. It is obvious that no satisfactory comparison of that kind can be made at the present time, because the circumstances under which we were operating in the half year to which I allude were of a nature which render it impossible to institute any comparison between the receipts. The rate of tariff was entirely different, and, therefore, any comparison of the receipts of the two half years would be entirely futile and misleading. However, on the 22nd of May last, the agreement to which I have alluded having been concluded and ratified on all sides, we recurred to the tariff of 2s. a word, and our experience since of the receipts under that tariff are so far satisfactory. The next topic to which I would draw your attention is to the expenditure of the half year. The expenditure which we can control, is, of course, only that of the offices in London, and at the stations. The other expenditure—I mean the money laid by to renewal fund, the payment of the different expenses connected with the working, independently of the office expenses, are permanent charges, and cannot be very much diminished or increased, but the expenses of the offices admit either of reduction or of increase. Well, it will be satisfactory to you to find that at the head office in London during the last year we have been able to make economy to the extent of £300 a year [laughter. A voice, "Wonderful!"] I do not understand the laugh. I do not know that I have said anything strange. Perhaps you would have liked an increase of £300. Different items of expenditure at the central office show an increase of £150, while other items exhibit a decrease of £474, showing on balance a reduced expenditure at the head office of about £325. The expenses at stations show a very different result. There, the increase of expenses has been about £4,400 in the year, but out of that we must deduct a large expenditure for the provision of new instruments, which, of course, become necessary from time to time. That accounts for £728. We have also been obliged to pay £1,000 for the use of a patent for Wheatstone's instrument. The expenditure on these items accounts for nearly half of the increased charge at stations. With reference to this increase of expenses at stations, the last time I had the pleasure of addressing you I mentioned that a reduced tariff involved additional work. The only object of reducing the tariff was to increase the messages sent, and an increase in the messages sent necessarily involved an increase of the persons who sent them. You cannot do double work with the same number of people, and that accounts for the increase in the expenditure at the stations to which I have alluded. You find that the increases in almost every instance are in those items of expenditure which involve the employment of an increased number of persons. The increase in salaries and wages is £1,200, there is the increase in the maintenance of land lines and instruments I have spoken of, the increase in stationery was £500, and the increase in lodging allowances, fuel, and provisions was £200. That accounts for a large portion of the increase in the expenditure during the past year. We may look to economies in this respect in future, because, as we have raised our tariff, I am afraid we shall not have as much traffic. We should be very glad to have an additional business, though it should cost us a little more to carry it, but I am afraid the increase in the tariff must necessarily reduce the number of words sent. That will enable us to make economies in the expenditure. So much for the receipts and expenditure. I now wish to say a word or two on the subject of the condition of your plant. The lines are all working well. You are aware that the Brest-St. Pierre cable, which had been in the water for thirteen years, developed a fault which suspended its operations during the last winter. We have sent an expedition out to repair that cable, and I am happy to be able to tell you that we have been able to raise that cable at a depth of very nearly 2,000 fathoms of water. We are not all nautical men in the room, and 2,000 fathoms means something like over 2¼ miles; and we have been able to get up that cable from 2¼ miles depth in the sea, and repair it. The repairs are not absolutely complete—that is, I cannot tell you that they are—because we have not had a telegram from the ship, but we expect every moment—literally every moment—to have a telegram informing us that the cable is thoroughly repaired and in good condition. In connection with this repair, we have performed a feat of some importance. We have laid down in the centre of the Atlantic, in connection with this cable, about sixty miles of new telegraph cable.

The MANAGING DIRECTOR (Mr. Henry Weaver): Ninety miles.

The CHAIRMAN: Ninety miles. Ninety miles of new telegraph cable. That telegraph cable is capable of being raised and being added to at any moment. It is a matter of as much certainty as it would be to pick it off the floor of this room. We can get at that, and, if necessary, make further additions of new cable to it. I, therefore, apprehend that the "life" of the 1869 cable will, by the operation we have performed lately, be very considerably prolonged. We have also put in the same cable a considerable portion of new cable on this side of the Atlantic—300 miles from Brest. So you can see we are, so to speak, darning the old cable as if it were an old stocking, and making it as good, and probably stronger, than it was before. Such is our own condition. We have had a good deal of competition from time to time to contend against, and I understand that we are threatened with further competition. Well, perhaps, if I were to offer advice to persons inclined to invest their money in a new telegraph operation, I might be considered as rather an interested counsellor, but I think you may have observed in the newspapers lately letters from my friend on my right (Mr. Weaver), which appear to me to demolish altogether the chances that this new cable will be able to make a livelihood. I may say that we have gone carefully into figures and facts connected with the laying of another cable, and I may add that if it came to a question of hostile competition, we can live and pay our working expenses at a rate of tariff which would not enable that cable to pay its own working expenses. Of course, when I say we can live, it would be a very miserable existence, as we should merely pay our working expenses and give you no dividend, which is a state of things I should not like to cultivate; but, on the other hand, our competitors would not be able to live at all—would not be able to drag out the miserable existence we should spend; and if men under those circumstances are so unwise, to say the least of it, to put their money into this projected undertaking, all I can say is that they deserve the fate I believe they will receive. We are told that these additional telegraphs are required in the interests of the public, that the public want to have telegraphy cheaper than they have it already. Now, it is not necessary to go back to the history of our Company in order to show you that enormous reductions were made by the board, before the question of competition arose at all, in the interests of the Company, and with the view of stimulating and increasing the traffic, and thereby to bring in a larger income for the shareholders. But there is another consideration, which I have before mentioned, and that is that when such a competition as that which I have attempted to describe arises, in which we can make an existence and our competitors cannot live, you may depend upon it that the next step in the interests of the public will be combination for which the public will have to pay. There is nothing in existence more true than that you cannot compel capital to work gratuitously any more than you can compel manual labour to work gratuitously, and all attempts to force down the remuneration of capital below what it will bear will result in the public having to pay a larger price for the accommodation and to remunerate the capital which it is attempting to crush. That is my deliberate opinion. I believe that where combination is possible competition is out of the question, and the public, instead of increased facilities and cheaper telegraphy, will have to pay a larger amount for the accommodation they will derive from these numerous cables than if they were satisfied with a fair rate of tariff from the cables which already exist, and which are more than sufficient to do the business with which the public supply them. Gentlemen, I do not think it is necessary for me to trouble you with any more observations. This, as you are aware, is an off half year. We have no dividend to declare—nothing of that description to bring before you, and we merely meet you to keep you fully informed as to the state of your undertaking, and as to the condition of the Company. I shall, therefore, merely conclude by moving—"That the report of the directors and accompanying statement of accounts to the 30th of June, submitted to this meeting, be and the same are hereby received and adopted."

Sir JAMES ANDERSON seconded the motion.

Captain TROTTER stated that he had been a shareholder for a great number of years, and had never sold a share. He had not had an opportunity of speaking for several years. He was quite certain that the board was exercising its best judgment in the administration of the affairs of the Company, but he did think it was open to discussion whether their policy was, and had been, the wisest policy. Their policy, in a word, had been, as the noble chairman had just said, combination—an endeavour to create a monopoly. This, however, was an age not favourable to monopoly, and he ventured to think that the remark of the chairman, that the public had eventually to pay for competition, was an argument which meant this—that the public would have to pay for all capital invested, well or badly. He did not believe that. He attended the meeting of the Company about six years ago, on his return from America, having travelled some 20,000 miles in that country, and he then expressed his belief, not in combination but in treating the public liberally, in being content with small profits, and letting competition come if it pleased. Most of them would remember when shilling inland telegrams in this country were anticipated as fatal to the prosperity of telegraph companies. No one present, however, he supposed, remembered how Sir Rowland Hill was thought a madman when he predicted the penny post instead of 1s. 6d. and 2s. 6d. He believed that every combination they had made in this Company, every endeavour to make a monopoly, had resulted in a considerable fall in the value of their property. He was one of those who would not have troubled to come to the meeting but that he had been seriously alarmed at seeing the capital stand at 50 per cent. discount. The policy of the Company had been persistently the same, and he ventured to believe that if they had been contented with a low tariff, and have left competition to come if it pleased, they would not now be receiving the small dividends which they were paid, and see half their capital virtually extinguished.

Mr. ASTON entirely agreed with the previous speaker. Was that meeting of shareholders then present in favour of combination or not? If they were, let them adopt the resolution. If they were against that policy let them consider whether it would be wise to pass the resolution, or whether a committee should not be invited to consider whether more backbone could not be appointed at the board. The board as represented by the chairman did not strike him as a strong board. As to the result of combination, in August, 1873, after the first amalgamation, their stock fell to 90, after the agreement with the Direct Company it went to 60, after that with the French Company it stood at 59, and after the agreement with the American Company it dropped to 52½. Such a state of things was not satisfactory, and he would move with the approval of the meeting, the appointment of a committee to consider the constitution of the Board. It struck him that there were many things a board might do besides that of combination. They had now a reserve fund of £400,000, and he did not see why they should go on adding to it. Their credit was good, and he did not think it was necessary to add to the reserve fund. There had been a vacancy at the board which had not been filled up, but he thought if the number of a board was fixed it should not be decreased. He concluded by moving the appointment of a committee to consider the constitution of the board, and the adjournment of the meeting to receive a report from them.

Mr. HENRY RUTSON, in seconding the amendment, supported the pre

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vious speakers. The board had gone on in the policy of combination, which did not appear very successful. He thought they could strangle competition if the meeting showed that it was strongly against it.

Mr. NEWTON did not quite agree with the appointment of a committee, but he was glad of the proposed amendment, as it would show that the Company would soon take steps to fight, and he agreed with fighting the competition by which they had been and were threatened. He objected strongly to combination, as it had always been fatal to this Company. The chairman had told the meeting on this occasion that they had picked up a cable from the middle of the Atlantic from a depth of two and a-quarter miles, that they had put in new cable, and that it could be picked up in future easily. That was one of the most tremendous facts ever stated. It established their property in such a manner that they need not go on building up a reserve fund, as had been necessary in former days, in face of the statements made by the chairmen of these companies that the life of a cable was only ten years. It was very clear that the shareholders could remain in it as investors, although generally speaking there was now such a great amount of speculation going on. With regard to competition, it struck him that in America it was the prosperity of shareholders that caused it. He had seen in the papers that a new combination was to be established on account of the good dividend paid. In this country, however, it appeared with these companies that adversity caused it. The adversity of the shareholders in these companies seemed to invite new competitors. How was that? He had heard it explained as being a great mystery, and that the only explanation could be that investors were crops of fools always springing up to help promoters. He thought the explanation was this—that the Atlantic Ocean offered to cable makers a great field for plunder. A cable contract came to something like £1,500,000, and that was a sum which offered considerable scope for plunder. Therefore the keenness of makers of cables was exercised. The way to fight such combination was not the plan adopted by the directors. The New European scheme he did not think was worth talking about. It had come to the last point, for he held a circular in his hand which contained an announcement of some private firm that they would give large commissions for placing its capital.

Mr. GRIFFITH stated that this Company started with a moderate capital, and by its amalgamations with others the capital had been "watered," increased to £7,000,000, with a decrease of dividend at the same time. Mr. Newton had made some very able remarks, and certainly it was not wise that they should merely combine with the directors of other companies, and the combinations be of no advantage to this Company. He agreed with all that Mr. Newton had said as to a warlike policy. Nine-tenths of the commerce of the world was carried on by telegraphy, and as commerce increased telegraphy must also increase. He could not say that the policy of last year had been altogether satisfactory. They anticipated war. Before the new company was started they lowered their tariff to one shilling, and that lasted ten months. If they carried messages for ten months at a price which was hardly remunerative, he thought they could not wonder if their dividend fell off. It was true that they were fortunate in having men on their board of great ability, but as Mr. Newton had intimated, there were men of great ability who were not on the board. He should be in favour of combination so far as to get a few of those men on their board. By that means they would have an increase in the power of their counsellors. The present position of the Company was somewhat critical. Their dividend had fallen off to a large extent, and he thought it would be wise for them to consider their future He was sorry to hear Lord Monck say that capital could not be compelled to work gratuitously. Such a statement was rather ambiguous. If the public had ultimately to pay for competition, the shareholders also had to pay for it by not receiving dividends. He thought they should do as had been suggested—look rather to the development of trade, seek to gain their fair proportion of that trade, and thus save the expense of going to war, the lowering of their dividends, and the necessity of having such large renewal funds.

The CHAIRMAN: I am very unwilling at meetings of this kind to appear to intervene before full discussion has taken place, and I have, therefore, abstained from stating my views at an earlier period on the amendment just placed in my hands. Now, you are all aware that this meeting is not one which has been called for the purpose of discussing the action of the directors, or the constitution of the board, or anything of that sort. No notice has been given of this amendment. It has been sprung as a surprise on us in the room without our knowing that any intention of the kind was entertained. It is not an amendment on the resolution which I had the honour of proposing at the opening of the meeting, because that resolution merely referred to the report and accounts laid before you; and according to the established rules of order which guide all meetings it is therefore entirely out of order, and I should be acting very improperly if I allowed it to be put to the meeting. There is another reason which I wish to lay before the meeting quite independently of the question of order. It is this: There are in this Company over 5,000 shareholders. No action of the board affecting the interests of the Company has ever been taken—I mean no considerable action has ever been taken without the shareholders having been called together, consulted, and allowed an opportunity of expressing their opinions on it. On no occasion of that description has there ever been—I was going to say any opposition to the action of the board, but if so it has only been of such a partial description as to bring out more prominently the support received by the board from the great body of the shareholders. I have no feeling in the matter. Mr. Newton may rely on this—that I have no objection to his discussing my action or connection with this or any other Company; but I do not think it fair to the board or the shareholders of the Company to allow such a meeting as I see before me, however respectable the individual men may be, but which numerically bears no proportion to the shareholders of the Company—I do not think it would be right of me, even if the amendment were in order, to allow it to be put. If any action is wished to be taken, let notice be given, and if it is of such an urgent character as to necessitate its being discussed before the next meeting, the Articles of Association provide a means by which the shareholders can be got together, at which you can get their honest opinion on the question. But I cannot stand here, even if the amendment were in order, and allow it to be put to such a meeting as this in the absence of nearly all the shareholders of the Company. It is no disparagment to the gentlemen present to say that they are a mere drop in the ocean compared to the number of shareholders in the aggregate. On both these grounds I, as chairman of the Company, decline to put the amendment. Here is the clause in the Articles of Association for the holding of an extraordinary meeting. Having read Clause 35 he continued:—That is the mode provided by your Articles of Association for considering such a proposal as this. I challenge those who have brought forward this proposal here to take the course provided by your Articles of Association, and I am ready to meet them foot to foot and hand to hand whenever they propound their resolution before a meeting of shareholders properly called to consider it.

Mr. ASTON contended that his amendment was strictly in order. He felt very much flattered by the objection which had been taken by the noble chairman, as it appeared to him to admit that if it were put the meeting would endorse it.

The CHAIRMAN: By no means.

Mr. ASTON: If not, why object? He had not come to the meeting with any prepared resolution. He had seen in the *Economist* the figures he had quoted. There was no doubt that it was in their power to adjourn the meeting. He did not see the use of calling the shareholders together if when any point arose they were told that they must call an extraordinary meeting to consider it, and at a cost of some £18 or £20. As to the directors being taken by surprise, all the world was full of the question of combination. They had had in the past all the combinations he had mentioned, and now another one was foreshadowed. (The chairman dissented). He did not wish to press the amendment, but he contended that he was in order in moving the adjournment of the meeting. There was not enough backbone in the board, and he held that they wanted new blood. He thought it would be very ill-advised if the chairman objected to the amendment, which was merely as he had suggested, a committee to see whether it was desirable to appoint any new blood to the board.

Mr. NEWTON thought it would be a misfortune and a mistake if the chairman did not allow the amendment to be put. The shareholders who were present had attended at considerable trouble, and those who had stayed away had done so for their own convenience, and he objected to a meeting of shareholders being stifled, however small the attendance might be.

Mr. ALFREDS observed that the shareholders who were absent had had the same privilege of attending the meeting as those who were in the room, and if anything were done in their absence they must suffer, and not those who had taken the trouble to be present. The argument of the chairman that he could not entertain a proposal before a meeting numerically small was contrary to English law. Take the case of a parish vestry, where they could put on the parish any amount of money they pleased. If there were only three persons present the whole parish was taxed as if all the parish had attended, and he entertained the opinion that that was the law in all meetings. Those present had the right to do and act as they pleased, and they had not to consider those who were absent. As to combinations and the mode in which they were treated outside he thought there might be some amendment. No sooner did they come to peace with one company than another arose. The question was how could they stifle the waste of the money of the shareholders. If fighting was a better way to stifle these competing companies, and the contractors connected with them, he should say fight them instead of combining with them. No sooner did a combination take place, and peace was restored, than some other persons started up in the expectation of terms being made with them, as in the case just previously settled. He, however, did not think that the laying of these new cables was prejudicial to them, but rather beneficial [laughter]. If they could buy these new cables at half the price they were laid for, where was the disadvantage to them? It was, however, very certain that the new company which was trying to obtain English capital would not be able to get it when this Company's shares were selling at 50. Who would give 100 for an article he could buy for 50? Were the English people such silly folk as to do so?

The CHAIRMAN: I think the position I took up has been rather misapprehended. I told you in the first instance that I ruled this amendment entirely out of order. The gentleman who has just sat down says that a meeting of shareholders have the right to do what they like; but if they mean to conduct their business in a businesslike manner, they must be guided by the constitution of the Company to which they belong. I am not a novice in these matters. I have been a good many years your chairman, and have had some experience in the duties of chairman elsewhere, and I say deliberately that this amendment is out of order. If gentlemen are disposed to dissent from that there is no doubt that there is a remedy; but, standing here as your chairman, I have to settle what is out of order and what is in order, and I say that this is out of order. My reference to the shareholders present, numerically, was to show that, even if the amendment were in order, I should not allow a meeting like this to pronounce on the interests of 5,000 shareholders in the Company. I now move the adoption of the report and accounts. Having submitted the resolution in the usual way, he said: I pronounce that the resolution is carried with four dissentients.

Mr. ASTON contended that the amendment should be put.

The CHAIRMAN: I decline to put that amendment. The resolution is carried.

The SOLICITOR (Mr. Birt) hoped they would not leave the meeting with the idea that the chairman had made any irregular decision. Having been the solicitor of the company since its formation, and having for more than 20 years had the duty of attending such meetings, he had had some considerable experience in these matters; and he ventured to say that Mr. Aston was perfectly well aware that it would be utterly unconstitutional and irregular to have put such an amendment.

Mr. ASTON: I deny that *in toto*.

The SOLICITOR (continuing), held that the chairman had been properly warranted in his decision, not only by the ordinary rules governing such meetings, but by the Articles of Association of the Company, and he would have been sorry had his lordship gone contrary to the course which he had followed.

Mr. ASTON held that he had been perfectly entitled to move the adjournment of the meeting.

The SOLICITOR acquiesced as regarded the adjournment of the meeting.

A SHAREHOLDER spoke of the "enormous additions" to the reserve fund, and argued that £100,000 would be quite sufficient when they considered that the Company had now four cables in full working order. [A voice: "Three"]. An intimation had recently been given in the papers that they would have four shortly, and taking that into consideration, and the

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poor dividend they received, he thought that £100,000 was quite sufficient for the reserve fund. They had now £400,000 in the reserve fund, and if they put by £100,000 a year more they would soon have enough to lay another cable. They had now the Gould Company, the Direct Company, and the French Company, and, in fact, he believed that they had eight cables in working order, and under these circumstances, whatever Sir James Anderson might say to the contrary, £100,000 a year was sufficient. He would not move any resolution on the subject, but would leave the matter to the directors.

Mr. NEWTON, in proposing a vote of thanks to the chairman and directors, trusted they would remember that the shareholders were a fighting body, and would take measures to protect their interests.

The motion was seconded and carried, and

The CHAIRMAN having briefly acknowledged the compliment, the proceedings terminated.

SOUTH EASTERN (BRUSH) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of this Company was held on the 9th inst. at the City Terminus Hotel, under the presidency of Sir Michael Kennedy.

The SECRETARY (Mr. Alfred Jermyn) having read the notice convening the meeting,

The CHAIRMAN said: This is a special meeting convened for the purpose of making certain alterations in our Articles of Association. Those alterations have been dictated to us by the Committee of the Stock Exchange, and it is necessary that we should adopt them before the Stock Exchange will grant us a quotation. They have already granted us a settlement, and it is only on this further ground that we trouble you on this occasion. We are not yet in a condition to apply for a quotation, inasmuch as we have not sufficient capital subscribed. Under the rules of the Stock Exchange a quotation cannot be granted except in cases where capital has been paid up to the extent of £50,000. The alterations we have now to consider are not very numerous or very important in their scope, and in no way do they affect the interests of the shareholders. There is, therefore, no doubt that you will approve of them without any difficulty. The first alteration is in Article 4, and the object of it is to prevent the directors, without the assent of a general meeting, from issuing any shares at a discount—that is, to prevent the directors from "watering the capital." The next alteration is in Articles 81 and 89, and the object is to reduce the term of office of the directors from the year 1886 to 1884 ("1884" being inserted in those Articles instead of "1886"). The next alteration is in the omission altogether of Articles 85 and 100. The 85th Article the Stock Exchange require to be expunged, apparently for the reason that it would enable important considerations to be decided by correspondence instead of being thrashed out in a general meeting. The omission of Article 100 is similar in its scope, but has application to the directors, to prevent in the same way matters which properly should come before a meeting of the shareholders being settled by correspondence. He concluded by moving a resolution altering the Articles of Association in accordance with the manner indicated in his remarks.

Mr. FESSER seconded the motion, and it was carried.

The SECRETARY then read the notice convening the first general meeting of the Company.

The CHAIRMAN: Gentlemen, this is our first (or statutory) general meeting. As usual on these occasions we have not very much to communicate to you. Electrical undertakings, like all other enterprises of similar character, require, when they come into existence, to be worked on gradually. Up to the present time our work has been chiefly concerned with preparation and organisation for the business which is, no doubt, before us as time goes on. With the decline of the year the demand for electricity will become greater than we can expect it to be during the long days and short nights of summer. The Company was incorporated on the 2nd of May, with a capital of £100,000 in 20,000 shares. The number of shares applied for was 104,730, or more than four times the number offered, and including 400 paid up vendors' shares, all the shares were allotted. As soon as we were in a position to do so we applied for a settlement. The date of our application was the 3rd of June. A settlement was granted on the 29th of that month, but we cannot obtain a quotation till capital has been paid up to the extent of £50,000. We did not consider it advisable to make the call of £1 a share due on the 1st of June, because we had no immediate prospect of utilising the money advantageously, and we thought it would be more for the interests of the shareholders that we should not call up additional capital until we were in a position to employ it advantageously. We engaged offices at 110, Cannon-street, and we made an arrangement by which we share those offices with the Provincial (Brush) Company, of which, as I dare say you are aware, your directors are also the directors. Mr. Offor, our first secretary, we appointed our general manager, as we thought his great experience of electric business in general and of the Brush system in particular would be more advantageous than if we continued to employ him in the purely ministerial office of secretary. You are fortunate enough to have the services of Mr. Beeman as electrical engineer. This gentleman had been the inspecting engineer of the Anglo-American Brush Corporation, and had had charge of the City lighting. He is an officer of experience and talent, and has patented several useful inventions in reference to electric lighting appliances. Under our engagement with him we are entitled to share in any of his future discoveries. I may say also that that is of great advantage to us. I cannot at present enter into details, it would not be right or proper to do so, but I may say that I see the near approach of the results which I think will be very advantageous to the Company. Mr. Offer, Mr. Beeman, and our secretary also act in similar capacities for the Provincial (Brush) Company—an arrangement which is beneficial and economical to both. As soon as our organisation has been completed we shall be able to lay the foundation for the important business which I have no doubt is evidently before us. We have advertised in certain papers in our three counties, and we have circulated a statement drawn up by our manager which gives full information in regard to the Brush system, and with details as to price, cost of installations, and other useful information. Our manager, our travellers, and some of our directors also have visited some of our chief towns, and I may say that they were everywhere well and favourably received. I am bound to say in every instance the answer was that, however well disposed towards the electric lighting they were, they could not take any steps till the Bill now before Parliament had become law. In addition to other business of a less important nature we carried out successfully a very large installation at Parkeston Bay, near Harwich, for the Great Eastern Railway Company. I believe this to be only the forerunner of very much more extensive business in the same direction in the future, Generally, I may say that we have had numerous applications from private firms and individuals in reference to installations and the use of our system, but we have been met by two difficulties—one that I have already alluded to, the want of legal power for laying down our mains and the means of supplying electricity, and the other with reference to a battery or accumulator, which we find to be most important—indeed, an essentially component part of every large system of incandescent electric lighting. Both these difficulties I may say are now in process of being removed, and will, I believe, shortly disappear. We have taken part in a very important movement, and have united with the other Brush companies in forming a Brush Council or Conference, which will take into its consideration the subject of our common interests, and will concert common action, and protect our common interests. Delegates from each of the companies have already met, and have considered and arranged their future mode of proceedure, and they have already passed important resolutions in reference to the quality and price of the machinery and plant which, under our licenses, will be obtained from the Anglo-American Corporation. I think you will see that as all the Brush companies work under the same licenses, but on totally distinct and separate grounds and localities, their united action must be very powerful, and cannot but be beneficial to the common Brush interests. I will now say a few words as regards the Bill on Electric Lighting. All those concerned in electric lighting must have followed the course of that Bill with a great deal of interest, and, probably, in some cases with a little apprehension. I was prepared to address you on this subject in a somewhat different strain, but I am happy to say that the Bill in committee was yesterday amended in a very important particular. The period for which licenses may now be granted, with the assent of the local authorities, was altered from five years, as originally drafted, to seven years, and the period for which provisional orders may be procured under the direction of local boards has been altered from 15 to 21 years. This concession, taken into account with the compulsory purchase clause, is very important, but I think, gentlemen, that we should, as far as lies with us, not stop here, but should endeavour, by agitation and such means as may be within our power, to obtain a revision also of the compulsory purchase clause. That clause seems to me to be extremely inequitable, for it provides that electrical companies shall be compelled to sell their undertakings at the close of the period named for the mere value of the works and material, without any allowance whatever for the goodwill of the concern. I do not think, gentlemen, that that clause will stand, but at present we must do the best we can with the Bill, as it has been amended. It is very encouraging that there is a general and growing opinion that there is a great and immediate future for electric lighting, and wherever this subject is discussed, whether it be in Parliament or out of Parliament, or in the columns of the newspapers, that view appears to be strongly held. I for one am entirely in accord with the remark made in the leading article in *The Times* of the 17th of July to the following effect—that there was a vast field for electric work, and so far from holding that there would be a difficulty in adopting the use of electricity, those concerned in its distribution would be speedily applied to by more customers than they could deal with. That, Gentlemen, has been our own experience already. As regards action in connection with the Electric Lighting Bill, I may state that for some time past we have had it under careful consideration. I cannot enter into details now—it would not be advisable to do so, but I can assure you that our arrangements are such that we can take necessary action as soon as the Bill has been passed.

Mr. ROBINSON asked if the Company had made any contracts yet?

Mr. STEWART inquired if any negotiations for the sale of sub-concessions were being carried on?

The CHAIRMAN: Nothing yet, in consequence of the difficulties interposed by the state of the law.

Mr. STEWART asked in what securities the money in hand had been placed?

The CHAIRMAN said that the greater part was in the bank on deposit.

Mr. STEWART would like to know if the prospects of the Company were as good as when the prospectus was issued. It had been stated in Parliament that 90 applications had been made for the introduction of electricity. Had this Company applied?

The CHAIRMAN replied that their prospects were certainly as bright, indeed, considerably brighter, because the time was approaching for effective action by the possession of legislative powers. The Company could then compete successfully with gas.

Mr. STEWART asked what had been done to obtain an accumulator?

The CHAIRMAN replied that they had hopes and prospects of settling that very important question soon. He hoped they would be content with what he had now said. This Company had not made application.

Mr. FESSER stated that the prospects of the Company were much brighter now. People, however, appeared to be as despondent over the electric light now as they were over jubilant at first. He had not the slightest doubt that it would supersede gas. He had seen in the newspaper statements that recent experiments had shown the electric light to be five or six times dearer than gas. They should, however, consider the conditions. In the experiment tried by the City Commissioners the conditions were one year's lighting, *i.e.*, they were to take up all plant at the year's end. Gas would be 40 or 50 times dearer than now under similar circumstances. If the law were in their favour they could get private lighting to supplement public contracts, and then they could easily compete with gas.

A SHAREHOLDER asked if there was likely to be formidable competition in their districts?

Mr. OFFOR: The law of "survival of the fittest" would determine the question, and, as they believed the Brush to be the best system, they had no fear. It was, he said, the only practicable system at present. The Crystal Palace Exhibition had confused the public mind. They saw lights with no evidence of comparative cost. Messrs. Siemens Bros. had lighted a district in the City with twelve or fourteen dynamos, but the Brush Com-

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pany had lighted that area with one machine from their works at Lambeth for a circuit of 3½ miles. Then, at Parkston Fay, this Company had supplied the light within a week of the contract being signed. They had made many installations to make their light known. At Richmond during the past week they had supplied the light at an enormous *fête*, attended by 15,000 or 20,000. On the previous night he himself had explained their system to a Blue Ribbon Army meeting. He had received a paper from Tunbridge Wells that morning giving an account of a meeting of the Commissioners, where an interesting discussion had taken place with reference to the proposals made for lighting the streets. There was evidently a gas interest there. Some member of the Council said that the electric light at the Albert Hall had gone out suddenly. Another member remarked, " Why, the same thing happened with the gas here." Another added that that had happened once or twice before. The light often went out from some temporary derangement of the machine, but that could be remedied at once, and the whole town was alight again. With gas each lamp would have to be lighted separately. Accidents from gas had been much more serious than could occur with the electric light.

Mr. Cunningham said he had been through nearly all the towns in their district, and not only was there no competition but they were the first in the field.

A vote of thanks to the chairman and directors terminated the proceedings.

PROVINCIAL (BRUSH) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of the members of this Company was held at the Cannon-street Hotel on the 9th inst. for the purpose of considering, and if thought advisable, of passing as a special resolution the following resolution, or a resolution or resolutions to the following effect, that is to say—

Resolved that the Articles of Association of the Company be and the same are hereby altered as follows :—

(I.) By the insertion of the following words at the end of Article 4, " Provided always that no share shall be issued at a discount without the sanction of a general meeting."

(II.) By the alteration in Articles 81 and 89 of "1886," therein mentioned, to "1884."

(III.) By the omission of Articles 85 and 100.

Sir Michael Kennedy presided, and stated the objects of the proposed alteration, which were exactly similar to those detailed to the shareholders of the South Eastern (Brush) Company. He concluded by moving the resolution, which was seconded and carried.

The first ordinary general statutory meeting was afterwards held, and the Chairman, in the course of his remarks, which were very similar to those made at the South Eastern (Brush) Company's meeting, stated that nearly six times the number of shares issued had been applied for.

The meeting closed in the usual manner.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Aug. 9.		Business Done Week Ending Aug. 9. Highest.	Lowest
Anglo-American	49,	50	49¾	49½
Do. Preferred	79,	80	79½	79
Do. Deferred	19½,	20½	20	19½
Brazil Submarine	11¼,	11¾	11⅝	11⅜
Cuba	9¼,	9¾	9⅝	9⅝
Do. Preference	15¼,	16½	—	—
Direct Spanish	5¾,	6¼	5¾	5¾
Do. Preference	15½,	16½	15¾	15⅜
Direct United States Cable	11¼,	11¾	11 11-16	11 11-16
Eastern Telegraph	10,	10¼	10 5-16	10 1-16
Do. 6 per Cent. Preference	12¾,	13	12¾	12¾
Do. 5 per Cent. Debentures, 1899	100,	105	—	—
Eastern Extension	11,	11¼	11 5-16	11 1-16
German Union	9¾,	10¼	10 1-16	9 13-16
Globe Telegraph and Trust Company	6¼,	6½	6⅜	6¼
Do. Preference	12¼,	12¾	12⅝	12½
Great Northern	12¼,	12¾	12¾	12¾
Indo-European	28½,	29½	—	—
Mediterranean Extension	2,	2½	—	—
Do. Preference	8½,	9	—	—
Reuter's	12¾,	13¼	—	—
Submarine	265,	275	—	—
West India and Panama	1¼,	1¾	1⅝	1 9-16
Do. 1st Preference	8¼,	8¾	8½	8¼
Western Brazilian	6¾,	7¼	—	—
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	103,	106	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1¼,	1¾	1⅝	1½
Oriental	⅜,	⅝	½	½
United Telephone	11,	11½	12⅜	11¼

ELECTRIC LIGHT.

Electric Light and Power	7-16,	9-16	9-16	9-16
Anglo-American Brush	15⅞,	16⅛	19¼	15
Eastern Electric	2,	2½	3	2

TRAFFIC RECEIPTS FOR JULY, 1882.

Companies.	June, 1882.	June, 1881.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	—	—	—	—
Direct Spanish Telegraph Company	1,846	1,448	398	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	30,070	31,751	—	1,681
Eastern Telegraph Company	—	—	—	—

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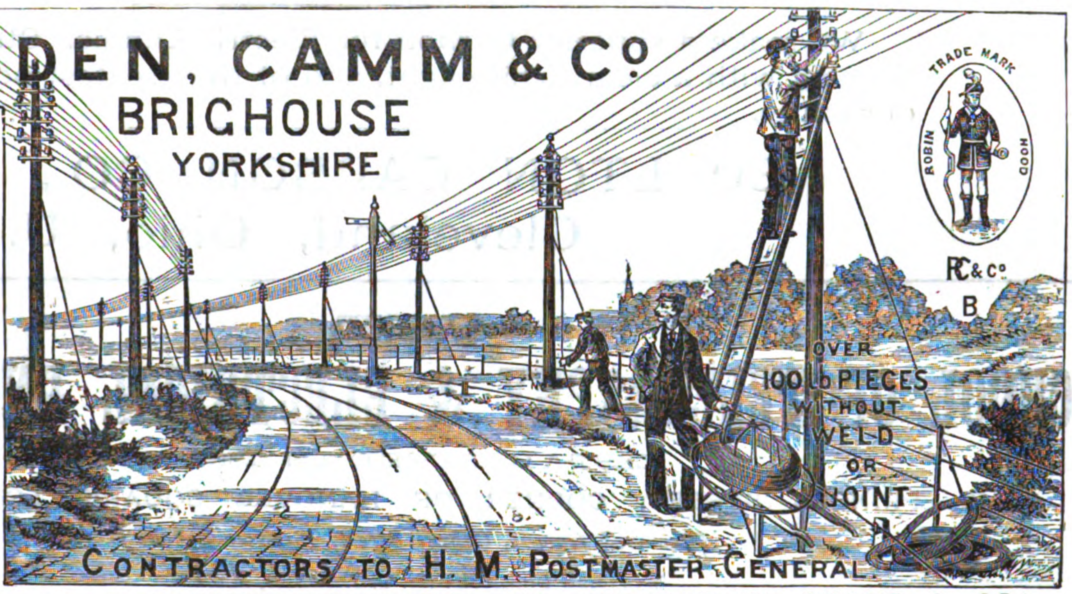
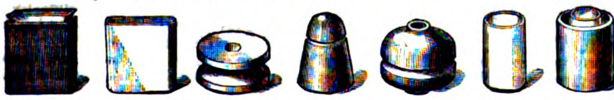


London Office: 72, KING WILLIAM STREET, E.C. (GEORGE W. SHARE & CO.)

PRIZE MEDAL, PARIS ELECTRICAL EXHIBITION, 1881.



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SLIP

The Grand Cafe at Paris.—The lighting of this establishment by means of incandescent lamps is in the hands of the Faure Company.

Repair of Atlantic Cables.—The cable of the Paris and New York Telegraph Company is now repaired, and also the cable between Rio Grande do Sul and Monte Video.

Telegrams for Egypt.—The Eastern Telegraph Company have established cable communication with Port Said, and telegrams for that place can be accepted, but at the sender's risk only.

The Brush Midland Company.—We are requested to state that Mr. James Whitehead (chairman) and Mr. Augustus A. Stenger have resigned their seats on the board of the Brush Midland Electric Light and Power Company.

The Brush Midland Electric Light, &c., Company.—This company has received an order to light up the factory of Messrs. Birkin Brothers, lace manufacturers, of Nottingham, with Brush arc and Lane-Fox incandescent lamps.

Electric Light in Belfast.—The eminent firm of shipbuilders, Messrs. Harland and Wolff, have ordered an instalment of Crompton and Co.'s electric light plant, consisting of dynamo machine and arc lamps, &c., through the Irish agent for this system, Mr. J. H. Greenhill.

The Edison Electric Light System.—We have received a nicely got-up price list from the Edison Company, which contains, besides the mere list of prices, an illustrated description of the various parts of Mr. Edison's system, and testimonials which have been received from users of the lamps, &c.

The Western and Brazilian Telegraph Company.—The traffic receipts for the three weeks ending 21st and 28th July, and 4th August, 1882, were £1,623, £1,882, and £1,661, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraphy Company (Limited).

The Opera House at Paris.—A fire caused by the electric light apparatus has created some consternation at Paris. No great damage was done, but faith in the freedom from fire by using the electric light is not so strong as it was. We still maintain that fire can be effectually guarded against, and when it happens it is the result of bad engineering.

The Iron and Steel Institute.—The autumn meeting of this institute is to be held in Vienna from Sept. 19 to Sept. 23. Many of the members will doubtless visit Munich, where an Electrical Exhibition will then be open. It is said that at this exhibition an exhaustive series of experiments will be carried out under the auspices of the German Government.

The Cuba Submarine Telegraph Company.—The number of messages passing over the lines of the Cuba Submarine Telegraph Company (Limited) during the month of July was 2,948, estimated to produce £2,800, against 2,494 messages, producing £2,397, in the corresponding month of last year. The traffic receipts for the month of May, estimated at £3,300, realised £3,544.

Electric Light in Newry.—A. R. Walker, Esq., J.P., has decided to light up his extensive flour mills by the electric light, and has given his orders to Mr. J. H. Greenhill, of Belfast, for Crompton's Bürgin machines and Swan's incandescent lamps. This order is the result of the highly satisfactory instalment of this combined system in the mills of Messrs. Furlong and Sons and Messrs. Hall and Co., at Cork, in December and January last, these firms having expressed their great satisfaction with the light.

The Telephone in Rio de Janeiro.—It is stated that the observatory at Rio de Janeiro has recently been connected by a telephone line with the shop of Mr. Ferdinand Rodde, situated in the centre of the town. The telephones connected with this line are placed at the disposal of officers of the navy, merchant service, and of the army, as well as professors, students, and others, so that they are thereby enabled to correct their chronometers by the observatory clock, or to communicate with the observatory for other purposes.

Telegraphy and Electrical Engineering.—The institution which has hitherto borne the title of "The School of Submarine and Military Telegraphy, Telephony, Electric Light, and Technical Instruction Company," located at 12, Prince's-street, Hanover-square, will, it appears, henceforward be known as "The School of Telegraphy and Electrical Engineering." It is now closed for the summer season, but on the 1st of September the pupils will reassemble, and fresh courses of lectures and instruction will be commenced.

Some Early Experiments to Connect Electricity and Magnetism.—Dr. Franklin remarked that lightning and electricity both possess the power not only of reversing the poles of magnets, but of destroying the magnetism altogether. Beccaria found that lightning gave polarity to magnetic bodies, and he conjectured that a regular and constant circulation of electricity from north to south might be the cause of magnetism in general. Van Marum, in 1798, experimented on the magnetic effects of electricity with a battery of 135 jars, containing 130 square feet of coated surface, with watch spring needles, from 3 to 6 inches long. Œrsted, in 1807, proposed to try "whether electricity, the most latent, had any action on the magnet," and his discovery in the winter of 1819 was the result of lengthened experiment.

Italy.—Mr. Shepherd, the agent of the Edison Company in Italy, has succeeded in forming a syndicate of the principal bankers in Milan for the purpose of working the Edison patents in Italy. Mr. Shepherd remains with them as agent-general. This gentleman has just been engaged in lighting up a portion of Udine with the Edison light, which has been such a success that he is preparing a contract for lighting the whole of the city. The motive force will be supplied by the river Ledra. The cities of Mortara, Pistoja, Faenza, Fano, Arezzo, Schio, and several others are also to be lighted by this system, and in Milan the Theatre Santa Radegonda has been purchased for a lighting station, and part of La Scala Theatre will be illuminated at this year's carnival from it, and the principal shopkeepers have ordered their shops to be lighted. One firm alone has ordered 1,200 lamps.

The Conductivity of Glass.—At a meeting of the French Academy of Sciences on the 31st July, M. Trousseau stated that he had been able, by means of a Lippman electrometer, to measure the conductivities of bad conductors, and, amongst others, glass. He found that ordinary glass is very sensibly a conductor, Bohemian glass less so, whilst crystal is not appreciably a conductor. In a discussion which followed on this announcement, M. Dumas remarked that this classification, from an electrical point of view, was a reproduction of that which had been established on the basis of the presence of alkaline salts in the vitreous matter. Crystal does not contain these salts, Bohemian glass contains but a small quantity of them, and ordinary glass is very rich in them. He asked, and in this he was supported by the opinions of M. Faye and M. du Moncel, whether these salts,

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either of themselves, or by reason of the water retained in them owing to their hygroscopic properties, did not offer the reason for the phenomena observed.

THE POST OFFICE AND THE TELEPHONE COMPANIES.—With reference to the subject of our leading article Mr. Fawcett made some further observations in the House of Commons, on Saturday last. Persons who were investing in telephone companies with the idea that they would some day be able to get favourable terms from the Government should, said the Postmaster-General, at once know the truth, which was this, that he did not think there was the smallest chance that the Government would ever buy up the rights of those companies. The policy which they intended to adopt was that of allowing free competition—competition amongst private companies, and the competition of private companies against the Post Office. After a time the public would be able to judge as to who did the telephone business best, and if this experience proved favourable to the Government, they would then have beaten the private companies in the fair, open field of competition, and would occupy the ground without any claim whatever for compensation, or the purchase of rights.

OPPOSITION TO PATENTS.—In the application for a patent for improvements in dynamo-electric machines, No. 5525 (1881), by Mr. W. H. Akester, F.S.A., of the Universal Electric Company (Limited), Glasgow, opposition was lodged on behalf of Mr. David Graham, consulting electrical engineer, and Mr. Rankin Kennedy, both of the Railway Appliances and Electric Company (Limited), Polwathe Works, Glasgow. The Attorney-General heard counsel for the parties within his chambers, Westminster, on Saturday, the 5th inst. Many declarations and exhibits were lodged on both sides, so keenly was the contest conducted. The Attorney-General, however, overruled the opposition, and allowed the patent to proceed. In another opposition to an application by Mr. Akester for a patent for improvements in electric arc lamps, No. 2419 (1882), which was also opposed by Mr. Kennedy, the Attorney-General heard parties on Monday, the 14th instant, within his chambers, and again overruled the opposition, allowing the patent to proceed, and ordered Mr. Kennedy to pay costs.

THE CHAIRMAN OF THE GAS LIGHT AND COKE COMPANY ON THE ELECTRIC LIGHT.—At the recent meeting of this company the chairman, among other things, said:—"I have never, from the time I saw it tried in Paris four or five years ago, had the least fear as to the effect of electrical illumination upon gas; and from that moment to this I have never altered my opinion. I am perfectly certain that, let them get as many Bills as they like, and as prolonged powers before they sell their properties to different corporations as they can, they will never be able to carry out what they profess. In their prospectuses you see that many of the electric light companies profess to supply electric power at a much more economical rate than we now supply gas; but 'the proof of the pudding is in the eating.' Let me ask any gentleman to name a company that has yet paid one farthing of dividend from electric lighting. What dividends have been paid have been paid, not from lighting, but from concessions granted to other companies; and they will have to smart for it most severely by and by. Let the first call come on some of these companies, and they will see what a mistake they have made in embarking in the enterprises which they have invested in. My objections to electric lighting have from the very commencement been two—the first was as to the unreliability of the light as a continuous light; and the second was as to the cost of the light when produced."

A NATURAL COPPER PLATING BATH.—Two years ago, at a mine operated by Wm. Utter, at Campo Seco, near Milton, water came in and work stopped. To keep the large iron-bound and iron-bailed bucket used to hoist rock from drying up and falling to pieces it was let down into the water. Next season when it was drawn up, lo, a miracle! It was copper-bound and copper-bailed. From this has sprung quite an industry, and the mine has been sustaining itself from ore water ever since. The water contains an acid which has the property of taking into solution the particles of iron thrust into it, and it has also copper in solution which is let go, particle by particle, as the iron is picked up. It is a simple chemical exchange, and this mine may make another profit still if it will get another chemical into the water which will make the acid lay down the iron which, as a black flood, the water carries down into the Stanislaus River. The copper industry consists in taking bundles of scrap iron and old tin to the mine, where it is thrust into vats of water caught up, in which the metals are soon changed to copper, the residue of the iron taking the form of a black stream and flowing away. To make sure of making the water swap all its copper for iron, which it is glad to do without boot, one vat is placed below another down the bank to the river, and when the water escapes it has eaten its fill of iron and left pay for its meal in genuine copper.—*Stockton (Cal.) Mail.*

THE ELECTRIC LIGHTING BILL.—On Friday, the 11th August, this Bill was read a third time in the House of Lords; on Monday, the 14th, in the House of Commons the Lords' amendments upon this Bill were considered. Sir J. Jenkins moved to reject the Lords' amendment which extended the period of compulsory purchase from 15 to 21 years.—Mr. Dillwyn supported the motion of the hon. member for Carmarthen.—Mr. Chamberlain said that during the two months that this matter had been under discussion very great progress had been made in regard to electrical lighting, and it now seemed probable that large installations would be made, involving an expenditure of hundreds of thousands of capital. He did not think that 14 or 15 years would be sufficient to meet the case of such a large expenditure of capital. The period of 26 years was, therefore, now proposed as a *maximum*, leaving it to the local authority in every case to come to an agreement with the company seeking permission to make the experiment, whereby they might consent to a shorter time, as the price they would pay for the withdrawal of the proposition of such local authority. —Sir J. Lubbock begged to correct a statement as to the Edison Company being the only one which had asked for the 21 years. On the contrary, the other large companies were of the same opinion. The Bill gave no monopoly for 21 years, but at the end of that period the local authority would have the right of purchase, which was a very different thing. His hon. friend, the member for Swansea, said that electric lighting was still in an experimental stage. There was a sense, no doubt, in which that was perfectly true. The light might, and probably would, be improved, but the experience on the Holborn-viaduct and elsewhere showed that it was eminently successful.—The Lords' amendment was agreed to without a division. The other amendments were also agreed to.

AT THE BRITISH ASSOCIATION FORTY YEARS AGO.—The first sentence of the following abstract of a paper by F. W. de Moleyns, read at the British Association in 1842, is very interesting, now that the world is beginning to correctly estimate the value of the application of electricity. The title of the paper was, "On an Economical Voltaic Combination of Extraordinary Power," and the abstract is given in the *Practical Mechanic* of 13th August, 1842. The author

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stated that while the discoveries of electro-magnetism gave promise of its ultimate application as a motive power far surpassing steam, it was a matter of much importance to discover a mode of charging or giving attractive power to *soft iron*, at a cost which should render it as a mechanical agent generally available. He had invented a voltaic arrangement, which he believed would be found to possess, in a very marked degree, this advantage. The combination consisted of an acidulated solution of nitrate of ammonia in contact with platinum, and a solution of muriate of ammonia and zinc. The nitrate solution is separated from the muriate by a diaphragm of wood, biscuit-ware, or other porous substance not acted on by the liquid. The acidulated solution is thus prepared :—Six ounces of nitrate of ammonia are dissolved in two fluid ounces of soft water, and this solution is then combined with an equal quantity, by measure, of the sulphuric acid of commerce. The acid is to be added gradually, and the vessel containing the mixture kept in a frigorific preparation, so as to prevent the heat evolved exceeding 100 degrees. The muriate is dissolved in soft water to saturation. The zinc is not amalgamated, and *cast zinc* is to be avoided. The platina is the thinnest foil that can be procured, and the author found that box wood, cut to the thickness of veneer, and, superficially charred on each side, might be substituted for the platina with advantage. With a combination consisting of half a fluid ounce of the acidulated nitrate solution, one ounce of the saturated solution of muriate of ammonia, a strip of platina foil, three inches by two, surrounded by a piece of sheet zinc of equal surface, he had succeeded in supporting a weight of 2,000lb. by an electro-magnet of the horse-shoe form, measuring sixteen inches from pole to pole, and three-fourths of an inch in diameter. The attractive force before contact was in proportion.

THE POSTMASTER-GENERAL ON TELEPHONIC BUSINESS.—In his annual report for the year ended 31st March, 1882, the Postmaster-General refers to telephonic business as follows:—"The question of the development of telephonic communication has engaged the careful consideration of the Department. At the conclusion of the suit referred to in my last report, by which the monopoly of the Postmaster-General was held to extend to telephones, licenses were granted to the United Telephone Company as representing the companies defendants to the suit, and to other private agencies, to carry on the business of a Telephone Exchange in London and in various provincial towns; the Department at the same time itself establishing exchanges in other places. The principle which underlay this arrangement was that only one telephone system should be established in any one town. Before long, however, I received numerous applications to grant telephone licenses not only in places where telephone exchanges have been established by private companies, but also where they have been established by the Post Office. Deputations waited upon me representing the United Company, and other companies connected with it, strongly urging that in the interest of the public it was desirable that private companies should have an opportunity of competing against the Post Office in those places where telephonic exchange business has hitherto been conducted by the Post Office alone. I have had similar applications to allow telephone exchange business to be established in places where the United Telephone Company, or one of its branches, has an exchange. In the result I came to the conclusion that it was undesirable in the public interest to create a monopoly in the matter of telephonic communication, and in future applications will be favourably entertained from responsible persons for licenses to establish exchanges under conditions which may be regarded as giving adequate protection to the public and to the Department. Under this new arrangement I consider that it will be desirable that the Department should, with your lordships' sanction, hold itself ready to establish telephonic communication where it is thought expedient to do so, irrespective of any private agencies which may be already licensed to carry on business there. Among the advantages which I believe will follow from this arrangement is the probability of its leading to a considerable extension of telephonic enterprise. Moreover, it will not only secure to the public the advantages of competition, but will enable them to judge for themselves whether they can best be served by private companies or through the agency of the Post Office. It must, however, be understood that in conferring a license the Department grants no power to erect wires overhead or below ground, and no power in regard either to streets or private property. Nor does the license confer any power to employ in the transaction of telephone business any instrument the use of which would be an infringement of a patent."

THE BINKO ELECTRIC RAILWAY.—This system, which is now being worked in the grounds of the Crystal Palace, is thus described by Mr. W. Grist in a recently issued pamphlet. —"An eight horse-power engine by Messrs. R. Hornby and and Sons is employed in working the primary dynamo, which is stationary, and which generates the current. Only about four horse-power of the engine is used for the requirements of the railway, and this power would be sufficient to work a line of three miles. The current generated by this dynamo is transmitted by underground cables to the two rails—one for the leading, the other for the return current. From the rails the current passes to the insulated wheels of the locomotive *and of the cars thereto attached, which are all electrically connected with the dynamo locomotive.* We have italicised here, as herein lies an important speciality of the Binko Railway. The current thus led to the dynamo causes its armature to rotate as explained above, and the motion thus obtained is easily, by the skill of the mechanical engineer, applied to traction purposes, over rails insulated as below explained. The length of the experimental railway is 350 yards; its gauge is, roughly speaking about twenty inches; and the speed attained is from eighteen to twenty miles an hour. The weight of the engine is two tons, and of the cars half a ton each, each car being constructed to carry ten passengers. The first locomotive of the International Electric Railway Company has been named 'Volta,' the second, now in hand, is called 'Ohm,' both names being intended to commemorate two illustrious pioneers in electric science. We have mentioned the 'Blucher' and 'The Rocket' as the prototypes of a long line of steam locomotives; and it is not too much to suppose that fifty or one hundred years hence 'Volta' and 'Ohm' will enjoy a similar celebrity as the illustrious ancestors of many thousands of electric locomotives. The station and offices are lighted by incandescent lamps, the engine which works the electric locomotive being also used for this purpose; and arrangements are being made for lighting the train from the same current as for the railway. All signalling work in the station and offices is performed by electricity, the current, where not dynamo-produced, being generated from Binko's new patent galvanic battery. Even the letter-box is arranged to signal the fact that a letter or note has been deposited therein, the postman's knock being thus obviated. Having stated the main features of the working of the Binko Electric Railway, we may briefly call attention to the main points in which it differs from, and,

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as the patentee claims, improves on its predecessors. First of the advantages claimed is electric connection of the cars with the locomotive and with the rails. Instead of the cars being so much dead weight dragged by the locomotive, they 'pick up,' so to speak, current-energy by their contact with the rail, and supply their quota of strength to the whole. We before claimed as a speciality of the electric railway that it was fed by its own path; but in the case of the Binko Electric Railway we may go a step farther, and say that the very journey augments its strength—'*vires acquirit eundo.*' A second advantage is the regulation of speed at starting. A sudden access of full current to a stationary electric locomotive is liable to produce an effect analogous to that of a sudden kick on the unsuspecting human frame. The initial velocity is not maintained, and injury to the mechanism frequently results. The Binko patent locomotive provides against this by a regulator consisting of a sevenfold switch, by which the current can be imparted in strengths varying from one-seventh to the full power. A third point is the regulation of speed during the journey. This is effected by means of a system of resistances under the control of the driver. The fourth point is that a perfect system of insulation prevents leakage, and obviates the need for the sectional system before alluded to. This is attained by laying in the chairs supporting the rails a bedding of insulite or other equally effective medium, or by insulating the rails from the sleepers by means of india rubber, ebonite, or other insulating substance, whereby even the spikes do not come in contact with the rails. Owing to this precaution, rainy weather does not affect the practical working of the railway."

A NOTE ON THE ELECTRIC LIGHT IN 1849.—Mr. J. O. Rutter in a little work on Gas Lighting has the following remarks on the electric light. The work was published by Messrs. Parker in 1849:—"This is not a new invention. As one of the means of illustrating the powers of voltaic electricity, resulting from the discoveries in that branch of science by Sir Humphrey Davy, the voltaic light, involved between charcoal points, has, from that time to the present, been familiarly associated with the operations in the laboratory, and the lecture room, both by amateurs and professors. Nor is its recent exhibition in London the first appearance of the light in public. About six years since it was shown in the streets of Paris, where, for a short time it excited as much attention as it has lately done in this country. As a philosophical experiment, and especially when seen for the first time, the electric light is as startling as it is beautiful. Those who have never witnessed its effects are unable to form any correct opinion on the subject. Its intense brilliancy, and the consequent depth, or rather darkness, of the shadows surpass all the ordinary phenomenon of artificial illumination. For a moment the observer seems to be deprived of the power of vision. To look *at* the light, excepting from a distance, is extremely painful, and to be *in* it produces sensations which at first are anything but agreeable. Many things are philosophically possible which are commercially impracticable. Sometimes, however, the difficulties are of another kind, arising not from cost of materials, but the skill required and the time employed in the use of them. Inventions which in our own day have excited the brightest hopes, and which, if a hundredth part of what was said of them had been realised, would in some sense have turned the world upside down, have passed away, and are forgotten, or are used only as philosophical toys. There is nothing disheartening in this. Mistakes can be easily accounted for. Inventors never profit by the failures, whilst they are often ruined by the successes of others. Whether the electric light will ever be so complete, both in its mechanical and voltaic arrangements, as to be of any practical utility, or whether it will remain, as at present, a wonderful illustration of electrical agencies and nothing further, are questions which must be left for futurity to answer. The man is more bold than wise, and proves himself no safeguide in such matters, who ventures to solve either of them now. That which appears impossible to-day might, perhaps, be easily accomplished to-morrow. The annals of science and of invention are crowded with examples in which one happy thought, one simple condition, one little lever, or wheel, or pinion has finished and crowned with success the labours (with its attendant losses and disappointments) of many years. But we must look also on the other side; and there are found discoveries and inventions and machines, without number, which, for want of a happy thought, a required condition, a lever, or wheel, or pinion in the right place still remain unfinished. In the mechanism of the electric light some improvements have been made. In other respects the progress is remarkably slow. Patent after patent has been granted; years of labour and large sums of money have been expended; but as respects real usefulness, nothing seems to have been accomplished. A light of dazzling brilliancy can be shown for a few minutes at a time. Sir Humphrey Davy did this, and hundreds of others, some for amusement, some for instruction, have done the same. Steadiness and continuity are qualities essential to all methods of artificial illumination. In each of these qualities the electric light is deficient. If it be so cheap, that light equal to one hundred candles costs only one penny per hour, if it be so easily managed that it can be as readily adapted in lighting a private house as the most extensive building, and whether the light required be equal to 10 or 100, or 100,000 candles, might it not have been expected, that privately, or in public at least, one specimen of the light would have been kept in action for a few hours every night to have demonstrated its capabilities. Those who understand the details of the process do not wonder that the electric light is intermitting and uncertain. To maintain, at a high intensity, an uniform power in a voltaic battery is sufficiently difficult; to adjust the carbon points, even by the aid of the most ably-constructed machinery, is, apparently, impossible. Increase or diminution of power in the battery renders necessary a new adjustment of the carbon differences in the quality of the latter, or the admixture of impurities also interfere with the success of the operations. It may be perfect in its motions, and exact in its graduations, but still it cannot *think* about its work, or *know* what it has to do, and hence, in this instance, it fails in performing all that is required. At one period of the process the carbon point may probably be required to move at the rate of 1-1,000th, or 1-10,000th of an inch in the same time. Herein consists some of the practical difficulties. These are only a small part of them. As respects cost, nothing at present need be said. It will be in time enough to discuss the economy of the process when all other objections, and especially those of manipulation, are cleared away. If electric power could be obtained without cost, that would not aid the invention. The causes of failure are more recondite than the prices of acids, and recent improvements notwithstanding, the electric light remains, what it has hitherto been, a very impressive, and very brilliant philosopical experiment, and nothing more."

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OSTROGOVICH'S TELEGRAPHIC PRINTING INSTRUMENT.

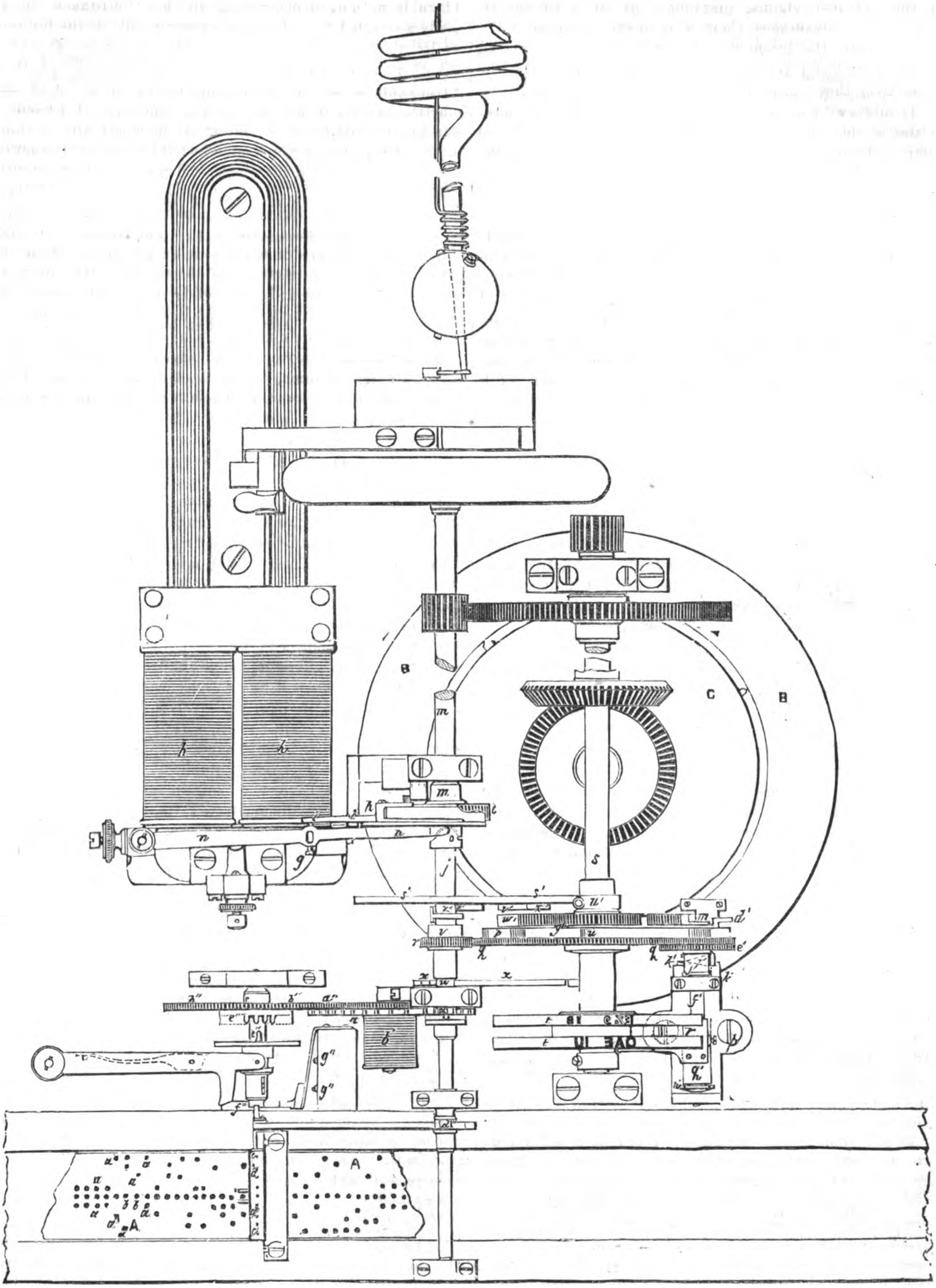

FIG. 1.

This instrument is based on the same principles as the telegraphic instrument universally known under the name of its inventor, Professor Hughes. Just as in the Hughes instrument the working is obtained by an electro-magnet,

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which by the action of the current neutralises the action of a permanent magnet, the printing is produced by the continuous movement of the type-wheels, correction takes place as each sign is printed, and the same time has been maintained for the mechanical operations in order to preserve the same duration of the current of the line, a duration necessary in order to communicate directly at any distance.

It differs, however, essentially, not only by several changes introduced into the mechanism, but also by two important innovations which have rendered it possible to attain a greater rapidity in transmission.

These two inventions consist (1) in the automatic manipulation, (2) in the manipulation of the alphabets on the type-wheel by the multiplication of the carriers.

The automatic action is obtained by a perforated band of paper, Fig. 1 A, on which the letters or signs are represented by two holes in a transverse row, *a*, *a*, determined by a third hole, *b*, in the middle of the band, and which serves as a rack to move on the strip of paper.

The two holes of the sign form one of the 28 combinations which may be obtained with eight units combined in pairs, so that all the 28 signs of the Hughes instrument are represented by a different combination; that is to say, by two holes in different positions in the same transverse row. By

If the carrier C, Figs. 1, 3, is then provided with two "rubbers," *g g'*, corresponding with the two rows of the contacts, *a a'*, of the distributor, insulated from one another, and having one rubber in communication with one pole of the battery, and the other (by the electro-magnet) with the other pole, it will be able to close the circuit on the passing of the two rubbers over the contacts of the distributor, determined by the combination of the holes of the perforated band, and to produce the requisite motion of the instrument.

Over Fig. 3 we may follow the circuit of the current, which, from one pole of the battery by the upper spring *h*, passes by the lower rubber *g* into the lower contact *a* of the distributor B, and, by its spoke, into one of the eight circles *c* of the lower part. By the terminal *d*, corresponding with the circle, it follows the communication established with one of the eight contacts *f* of the automatic instrument, to pass by the corresponding levers *c* and the metallic comb to another lower contact, and by the respective communication and terminal to another circle corresponding with the upper contact *a* of the distributor *g*, and at length completes the circuit by its spring, *h*, which is in communication with the electro-magnet *i* and the other pole of the battery.

This arrangement, which is well adapted for Hughes instruments as well as for all others on the same system, and

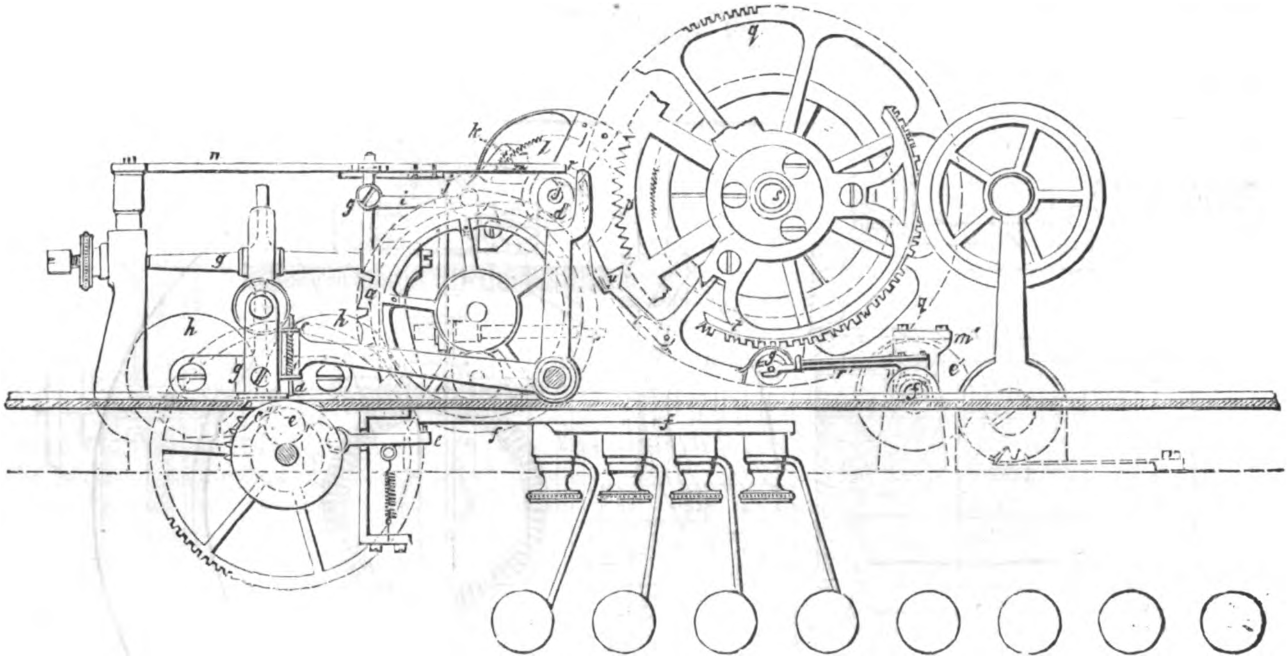

Fig. 2.

this practical arrangement, instead of a band too great either in length or breadth—evidently necessary if each sign were represented by one hole only—we get a band of paper of four centimetres in breadth, and of the length of the printing only. The automatic manipulator consists of a metallic comb, *c*, Figs. 1, 2, having eight points, *d*, kept in position by springs, and corresponding with the eight different positions of the holes of the strip of perforated paper.

At the lower part of the automatic manipulator are placed eight levers, *e*, Figs. 2, 3, which, on one side, correspond with the eight points of the upper comb, and, on the other side, with eight insulated contacts in communication with the distributor.

Every time the manipulating comb is lowered the two holes of the perforated band allow the two corresponding points of the comb to pass, and establish (by means of the two levers *e* pressed down by the two points) the communication required by the combination in the distributor.

The distributor B, Figs. 1, 3, has 56 contacts, *a a'*, Fig. 3, arranged in two rows of 28 each, corresponding with one another. These 56 contacts are connected at their lower ends with 56 spokes, *b*, which in their turn communicate, seven by seven, with eight circles, *c*, which, by means of eight binding screws, *d*, are placed in communication with the eight insulated contacts *f* of the lower part of the manipulator.

by which automatic manipulation is obtained, thus giving the full rapidity of transmission of which an instrument is susceptible, has rendered it possible to increase still more the maximum rapidity of transmission of the above-named instruments by the multiplication of the type carrier and the alphabets.

In the Ross-Ostrogovich instruments it is possible to increase the number of alphabets on the type-wheel to seven if we maintain the same ratio between the printing axis of the Hughes instrument, which is that of 1 to 7.

The manipulation of the carrier is obtained in a very simple manner by the application of several pairs of points or "rubbers" at equal distances one from another.

In this case it is evident that if a communication be established in the distributor the carrier may close the circuit and produce the movement of the instrument by any one of the pairs of points, and, consequently, by that one which passes first, which, necessarily, greatly increases the rapidity of transmission of the instrument.

In fact, the result obtained by this system exceeds everything that has hitherto been produced in telegraphy in the way of printing instruments, and starting with a transmission of from 25,000 to 30,000 letters per hour, which we may obtain by an instrument of three alphabets, we may succeed

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in transmitting from 36,000 to 40,000 letters, and even more, with instruments of five or more alphabets, without on that account lessening the duration of the current of the line, which always remains the same as in the Hughes instrument.

Mechanical Part.—The multiplication of the alphabets on the type wheel was consequent on certain changes introduced into the mechanical part of the telegraphic instrument.

The transmission of motion, the regulation, and the connections, are almost the same as in the Hughes instrument.

The connections, Figs. 1, 2, takes place by the direct action of armature *g* of the electro-magnet *h*, which strikes the stop *i*, Figs. 1, 5, of the free printing-axis *j*, and allows the ratchet K to meet the wheel *l* of the axle *n*, Fig. 1, of the fly. The armature, on account of the position of the magnet, is brought back to its place by a lever, *n*, which is connected with a screw-hole, *o*, on the free printing axis, partly in one direction, partly in the opposite direction, whilst a spring reconducts the "stop" *a* to its first position.

The correcting apparatus is quite different from those already known, and consists of a wheel with sharp teeth, *p*, equal in number to the letters of the type wheel; of a cogged wheel which fits into a pinion, *r*, placed on the printing axis, and which, being free on axis *s* of the type wheels *t*, moves only with the printing axis. This wheel (in letters of the three alphabets are placed on one wheel, and al the figures and signs of punctuation on a wheel parallel with the former one. However, by the passage of the strip of paper and its printing-roller from one type-wheel to the other, we get the letters, figures, and other signs printed in one single row. This displacement is brought about in the following manner:—The correcting-wheel bears laterally six small teeth, *d'*, Figs. 1, 4, at equal intervals, and placed conveniently so as to correspond with the three blank letters and the three blank figures, one being a little more advanced than the others. A small wheel, *e'*, Figs. 1, 2, 5, moving freely upon its axis, *f*, fits into the free wheel *q* of the axis of the type-wheels, in the ratio of 2:7, so that at each revolution of the pinion of the printing axis, which draws with it the free wheel, the small wheel can make only half a revolution. This small wheel has two rubbers, *g'*, Figs. 1, 4, 6, in a groove, pierced in the middle to allow the axle to pass freely, and one a little more forward than the other, so that each one may in its turn be met and pushed back by three of the six small "squares" or teeth, *d'*, placed under the correcting-wheel.

These rubbers have inside and at each end a tooth, *h'*, Fig. 6, arranged so as to meet a tooth, *i*, of a clutch collar, *i*, inside, in order to fasten the small wheel to its axis, and make it revolve.

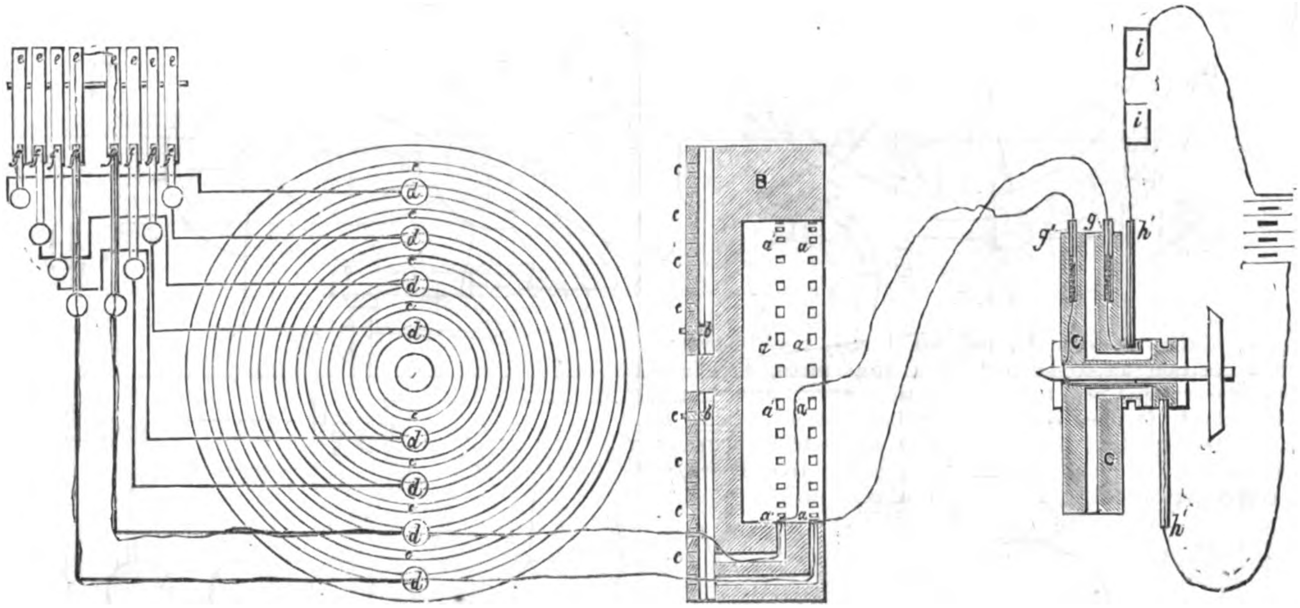

Fig. 3.

ratio 1:7 with its pinion) bears laterally seven hammers, *u*, at equal intervals, and in their striking part of the shape of the hollows of the teeth of the correcting-wheel.

When the printing axis begins to move, a cam, *v*, Figs. 1, 4, placed upon this axis, by a very slight rotary movement forces one of the seven hammers to penetrate into the hollows of the teeth of the correcting-wheel, advancing it or keeping it back, as the case may be. The hammer is brought back to its place by a spring as soon as the cam has passed. The printing takes place at the very moment when the correction is completed. For this purpose the printing axis bears another cam, *w*, Figs. 1, 5, acting upon an elbow lever, *x*, which supports the printing roller *g*, Fig. 5.

When the printing is finished the printed strip of paper begins to move on; for this purpose a tooth, Z, Fig. 1, on the free printing axis, catches the notch of a wheel, *a'*, Figs. 1, 2, in the form of a Maltese cross, so that the motion of the wheel may take place only during a part of the revolution of the said axis, the axis during the remainder of the time being able to turn alone. On this wheel is fixed a cylinder, with small flutings, *b*, Figs. 1, 2, which, as it moves, causes the paper to move on, the latter being slightly pressed by another small cylinder, *c*, Fig. 2, with free movement.

The instrument has two type-wheels, *t*, *t'*, and all the

The clutch-collar which as it revolves draws with it the axis, can, however, be transported longitudinally on the axle by means of two points, K, coveniently placed on the clutch-collar and by an inclined plane, *l*, fixed to the frame. By this displacement, the tooth *i* of the clutch-collar *j* can be met only by the tooth *h'* of the rubber under which the tooth of the clutch happens to be, and this is in order that the transportation of the printing roller may not take place at each blank, but only when it is necessary to pass from letters to figures, or *vice versâ*. A small inclined plane, *m*, Fig. 1, fixed to the support of the axis, brings back the rubbers at the end of the course to their normal position, setting free the clutch-collar. A spring which fits into a notch, *n*, in the axis, completes the half revolution of the system at the moment when the tooth of the rubber is leaving the tooth of the clutch-collar, and keeps the axis in a fixed and determinate position. Lastly, a groove, *o'*, Fig. 6, on this axis, half in one direction, half in the contrary one (and into which fits a small point, *p*, fixed to another clutch-collar, *q*, which supports the paper at *r* and surrounds the printing roller at *y*), forces this second clutch-collar to move longitudinally on the axis as often as the latter revolves.

Every time that one of the "squares" of the correcting-wheel pushes back a rubber, and the tooth of the latter meets the tooth of the inner clutch-collar the small wheel

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which bears the rubbers is fastened to its axis, and forces it to revolve. The axis in its turn forces the second clutch-collar to displace itself and to convey the printing paper and the roller under the other type-wheel, whilst the double inclined plane compels the inner clutch-collar to change its position, so that it is no longer met by the teeth of the same "rubber," but only by the tooth of the opposite rubber, which corresponds with another transportation.

The spacing is brought about by an arm, *s'*, Figs. 1, 7, fitted with a hinge, on a clutch-collar, *u'*, moving freely on

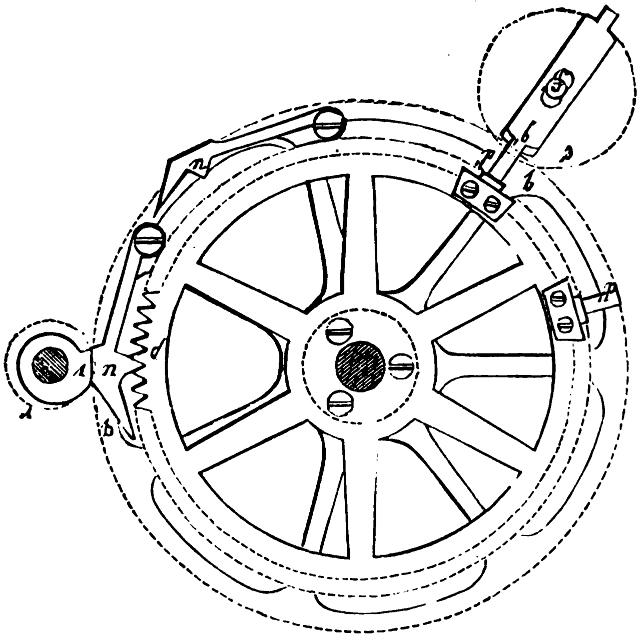

FIG. 4.

the axis of the type-wheels, and which may readily assume such a position as to be met by a stop piece, *v'*, placed under the ratchet *w* of the correcting wheel, and which, by its wheel, fastens the type-wheels to their axle. In this way the catch is forced to follow an inclined plane, *x'*, placed on the arm; and, setting the gearing free, it arrests the correcting-wheel and the type-wheels in the position

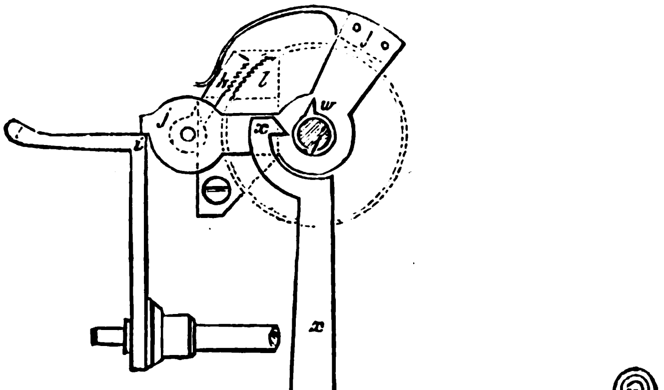

FIG. 5.

required by the blank. The free printing-axis, by means of two small inclined planes, *z*, one on the arm, the other on the axis, brings about the movement of the catch at the first passage of the current.

The band of perforated paper, which is employed in automatic manipulation, is set in motion by the telegraphic instrument by means of a wheel, *a'*, Fig. 1, placed on the Maltese-cross-wheel *a'*, which serves to move on the paper printed. This wheel fits into a second wheel, *b*, which enters the rack-holes in the middle of the perforated band, and the two cog-wheels at each movement cause the "transport-wheel" to move on by one point, whilst a cam, *d*, Figs.

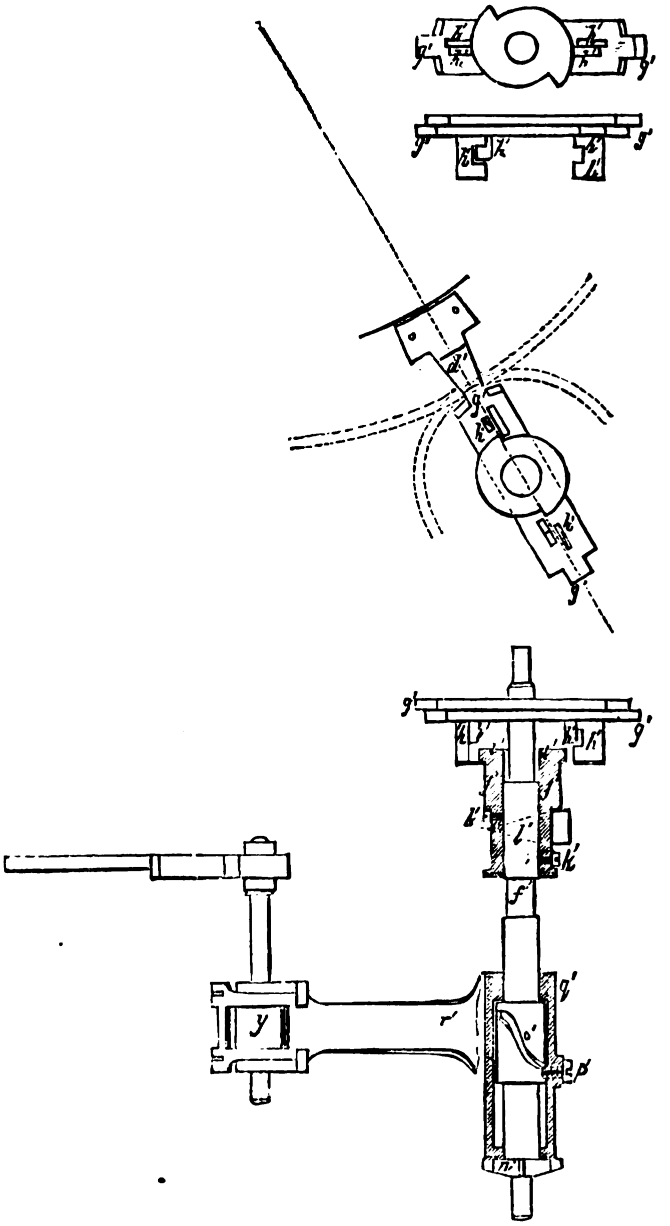

FIG. 6.

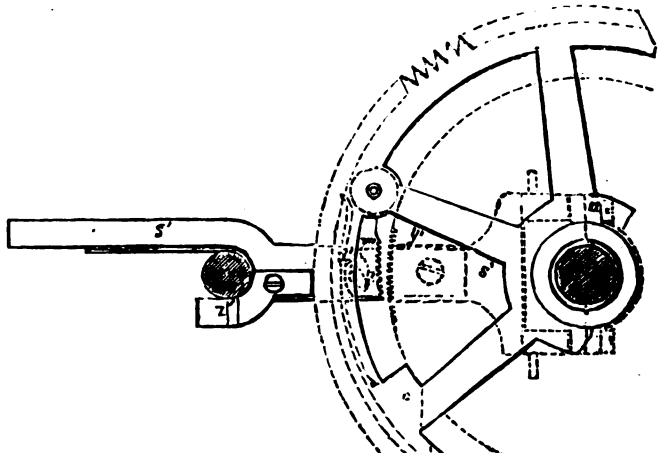

FIG. 7.

1, 2, placed on the extension of the printing-axis, holds up the manipulating comb.

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In this manner, if the automatic instrument does not establish the current, the telegraphic instrument cannot work, and as it does not cause the band of paper to move on, it is impossible for any sign to be emitted.

The automatic instrument does not form a part of the telegraphic instrument, but is attached to the latter by a connection, e'', Fig. 1, and an excentric, f'', placed on a lever moved by hand, which brings about the disengagement whenever desired. When the disengagement takes place the excentric raises the manipulating comb, and, if necessary, in one of the positions it may take establishes an electric communication, g'', which causes the instrument to make the blank sign necessary to preserve the synchronism of the two corresponding instruments.

For hand manipulation the distributor communicates with a keyboard with twenty-eight keys, each of which, having two contacts, establishes, when pressed down, the communication corresponding with the sign engraved on the key. By this arrangement it is possible to avoid the inconvenience which would be felt if the eight keys of the distributor were connected directly with only eight keys, an inconvenience which would force the operator to learn the combinations possible by always pressing down two keys at once to obtain the desired sign.

Lastly, a communicator establishes the circuit of transmission or of reception, and an electro-magnet, which is set to work by a manipulator, serves to interrupt, as well as for a a warning-bell. This same manipulator is employed also to send the line-current to the earth whenever it is necessary to regulate the synchronism of the corresponding instruments.

With the exception of different arrangements there is no difference between this instrument and the Hughes as far as the manner in which the current behaves is concerned.

As in the Hughes instrument, the current which has served locally for the disengagement of the transmitting instrument immediately afterwards passes on to the line, on which it remains during a whole revolution of the printing axis. Having maintained the same ratio as in the Hughes between the driving-wheel and the type-wheel and the pinion of the printing axis, viz., 1:7, the revolution of the printing axis lasts for $\frac{1}{7}$ of the revolution of the axis of the type-wheels, whence it follows that at the rate of two revolutions per second of the type-wheels the duration of the revolution of the printing axis, and, consequently, the duration of the line-current will be $\frac{1}{14}$ of a second, as in the Hughes instrument.

The line current goes to the earth as soon as the disengagement of the receiving instrument has taken place, whilst the distributor of the transmitting instrument remains completely isolated by an arrangement of the circuit during the time when the current is on the line.

Perforating Instrument.—To render automatic transmission by means of a strip of paper useful it was absolutely necessary that this paper should be perforated for the composition of telegraphic messages easily, accurately, and expeditiously.

With this end in view a small instrument, Fig. 8, has been constructed provided with 28 piston-keys, which (avoiding the inconvenience mentioned in the arrangement of the key board of the telegraphic instrument) perform, by one single operation, that is to say by their simply being pressed down, all the operations necessary for the regular perforation of the band of paper.

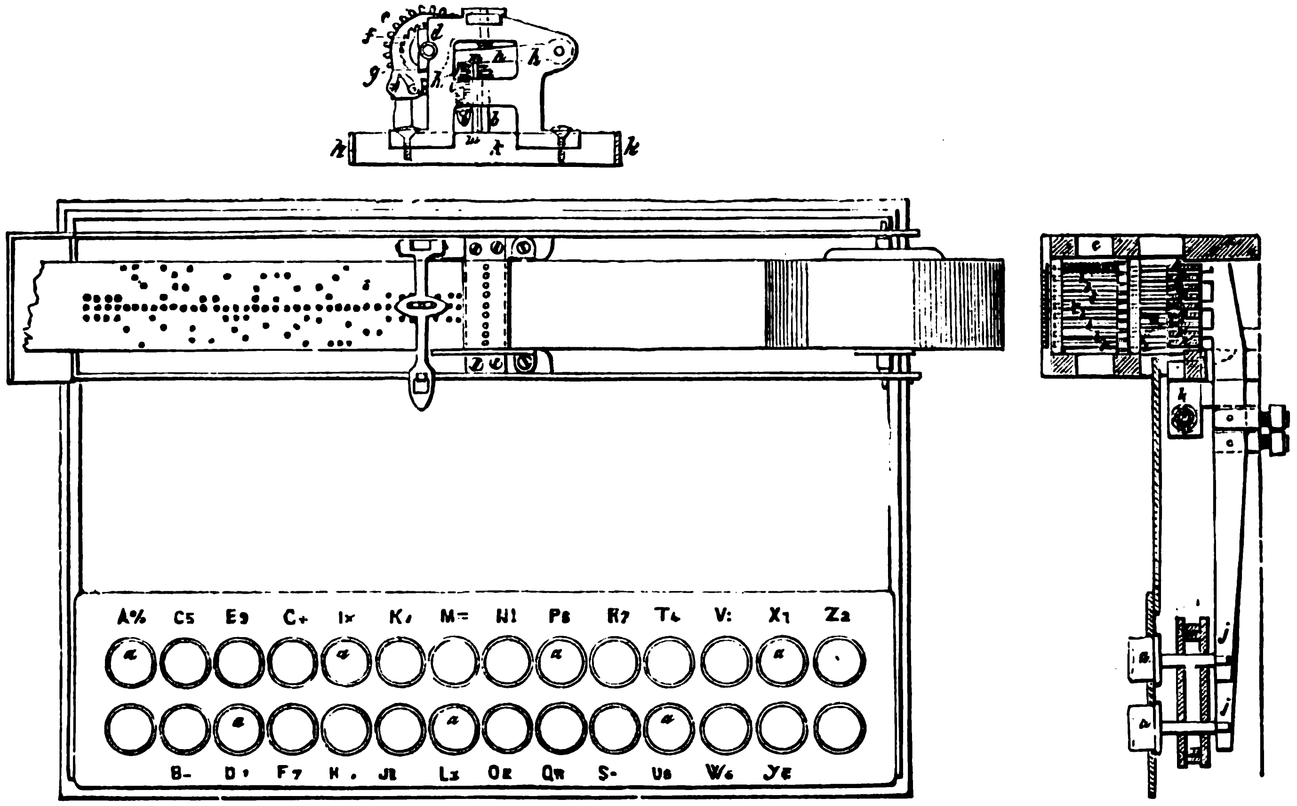

FIG. 8.

To obtain this result there are in a single row nine punchers, *b*, kept in and brought back to their places by springs *c*; eight of these punchers serve for the combinations of signs, whilst the ninth, in the middle, serves to make the rack for moving forward. On an axis, *d*, placed laterally and parallel to the row of punchers there is in the middle a small wheel, with points, *e*, identical with that of the automatic part of the telegraphic instrument.

On this wheel with points there are (1) on one side a wheel with a rachet, *f*, with a number of teeth equal to the number of points of the middle wheel, and moved by a catch, *q*, fitted to a lateral lever, *h*, which is provided with a recall-spring, *i*; and (2) on the opposite side a correcting-wheel, which by a toothed catch, the shape of the teeth of the wheel itself, arrests the axis in the position required for the regular spacing of the holes which form the composition of the message.

The nine punchers are connected with twenty-eight levers, *j*, which are situated under the piston keys of the instrument by means of nine double "squares," *h*, fitted to the same axis, *b*, so that when each key is pressed down the

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corresponding lever may raise three double squares at once, which in their turn raise three punchers, force them to pierce three holes in the paper, viz., the middle one, and the two of the required combination indicated by the sign engraved on the key. The middle double square, besides raising the middle puncher, raises at the same time lever *h* at *m*, whilst the recall spring of the lever, setting in motion the catch, causes the strip of paper to move on the required length. In this way the composition of messages by this instrument is rendered so simple and safe that any one who can read can also compose.

This ease in composition offers an advantage over other systems for telegraphic administrations, as well as for private persons, and these latter might make use of these instruments for their telegraphic correspondence over all lines on which this system of telegraphy might be adopted. This would save the companies considerable labour, since they would have only to measure the perforated strips of paper to know at once and accurately the number of signs presented for transmission and to fix their tariff.

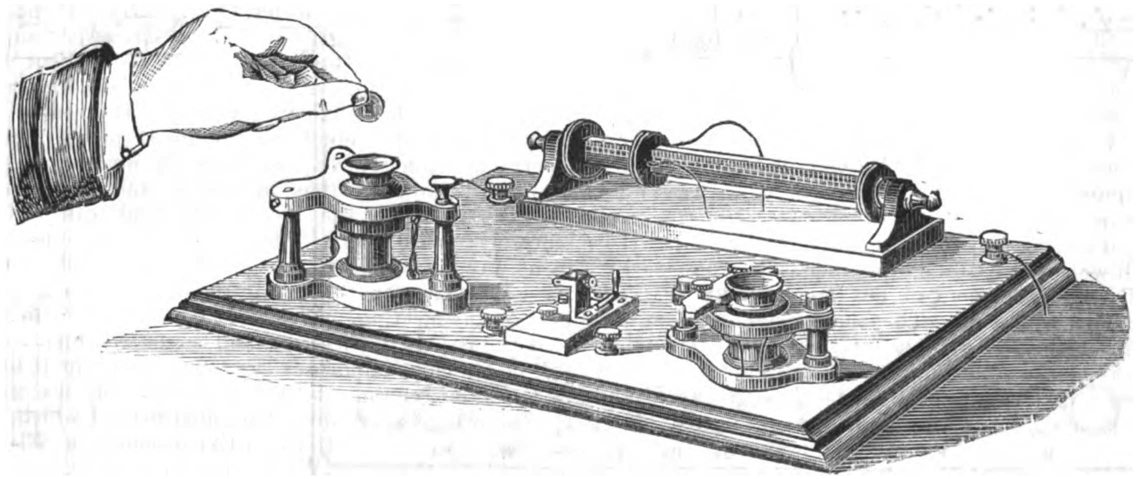
All telegraphic agencies which have to repeat the same messages several times, exchanges, important newspapers, &c., would certainly find it a great advantage to employ these perforators if a sort of precedence on the transmission of messages were accorded to them, and telegraphic administrations would undoubtedly be the gainers.

THE CRYSTAL PALACE EXHIBITION.

Post Office Exhibits.

(CONTINUED FROM PAGE 271.)

Our last figure is that of Professor Hughes's induction balance, which instrument, we think, was appreciated by visitors more than any other electrical appliance on the counters. Its power of detecting the slightest difference in the purity or weight of two coins of the same metal, or the conducting quality of wires—even, in fact, detecting an alteration in the molecular structure of similar metals, was remarkably instructive and interesting. But the instrument occasionally created amusement and surprise by actually measuring the hearing power of individuals.



Professor Hughes's Induction Balance.

The induction balance, as represented in the figure, comprises two distinct electrical parts. The graduated bar and its appurtenances at the back of the base-board is the "audiometer," and the upright cylinders occupying the left and right corners in front serve to compare coins, wires, &c. A switch between the cylinders enables the experimenter to put either the audiometer or the pair of cylinders in the battery circuit as required.

The audiometer is a bar of box-wood, about ten inches long, and divided into 200 degrees, having its zero about an inch and a half from the extremity on the right. On this bar are three box-wood circular frames, about two inches in diameter, and filled with wire. These we shall hereafter refer to as *coils*. One coil is fixed on each end of the bar, that on the right being half the thickness of the one on the left. The left coil and the central coil are each $\frac{3}{8}$ of an inch thick. The latter can be moved along the bar, and communicates with a Bell telephone. A current from a battery of a few Daniell cells circulates through a simple clock-work arrangement and the end coils of wire. The clock-work successively makes and breaks the circuit momentarily, and the direction of the current round the coil on the right is opposite to that on the left. Both coils tend to create a current of electricity in the central coil by their electric influence through space—a phenomenon called "induction." When a current is established in the central coil then the intermittent interruptions of the clock-work are audible in the telephone. Now, owing to the current traversing the end coils in opposite directions antagonistic magnetic powers are exerted upon the central coil, the preponderance of one power giving rise to the telephonic sounds caused by the induced current. If the central coil be close to the coil on the left, loud sounds are heard, and, as it is moved towards the right extremity of the bar they gradually diminish in strength until the inducing effects are balanced and the sounds stopped. The point marked zero on the scale is that which produces a perfect induction balance, hence if persons under examination lose the sounds before this point be attained, the degree indicated on the scale by the central coil shows comparative deafness, and in this way the arrangement becomes an "audiometer."

With regard to the second portion of the instrument, each cylinder contains two horizontal and parallel insulated hollow coils of wire. By altering the position of the switch-key the current is guided through the lower coil of each cylinder, and, like the audiometer pair, in opposite directions. The upper coils are united with a telephone in circuit. The lower coils form the *primary* circuit, and the upper coils the *secondary* circuit. No sounds ought to be heard in the telephone prior to metal being placed under the influence of the excited coils. Should, however, sounds be audible they can be nullified by means of the micrometer screw, represented on the top of the left cylinder, which raises or lowers the upper coil. Silence is maintained by the induced current in one coil completely neutralising the induced current in the other coil; but if, say, a piece of iron be put within the hollow of the coils of one cylinder, this balance of induction is upset by the electro-magnetic action on the iron, and the regular interruptions of the circuit become distinct in the telephone. An exactly similar piece of iron put into the opposite cylinder would restore the balance and restore silence. In the figure a hand is represented in the act of dropping a coin into a box-wood cup which is in the magnetic field. The opposite cylinder is provided with a similar cup. We will suppose the cup on the right side to have a coin lying flatly on the bottom, and consequently producing sounds in the telephone. Directly a coin of the same sort is dropped into the left hand cup the sounds either stop entirely or become very weak. We learn that absolute silence is evidence of two coins being alike in purity and mass, but to

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find such a pair often necessitates many trials. To understand how the instrument is employed for measuring the difference between ordinary coins and standard coins of the same metal our readers are asked to remember that all discs of diamagnetic metals such as gold, silver, copper, &c., produce the maximum strength of sounds when parallel with the coils of wire, that is, when flat on the bottom of the cup, and *no* sounds when perpendicular to the plane of the coils. Moreover, if a disc of either of the metals alluded to be turned slowly from a vertical to a horizontal position, while under the influence of the coils, the sounds in the telephone gradually vary in strength from silence to greatest loudness. Let us imagine that we have got two sovereigns of equal purity and weight. Now, if we reduce the weight of one a little by scraping the edge of the coin, and re-compare the two, feeble sounds occur (assuming each sovereign to be flat on the bottom of its cup). We will leave the coins in the cups, and regard them as the standard coins, calling the heavier 100 and the lighter 99, so that the conditions are as 99:100. Above the cup containing the 99 standard coin is placed a small horizontal axis having a multiplying index needle fixed on one end at right angles. The free end of the needle moves in front of a scale. The ordinary sovereign to be compared with the standard coins is attached to the axis in a way which enables the experimenter to turn it from a vertical to a horizontal plane in the magnetic field. The ordinary coin, therefore, gradually adds its effect to that of the 99 standard coin below, and, at last, the combined power just balances the effect of the 100 standard coin in the other cylinder, causing the sounds in the telephone to cease. The degree indicated by the index needle represents a certain value to the assayer.

If discs of unlike metals, having the same dimensions, are tested singly in one cup, sounds of unequal strength appeal to the ear. This difference is also apparent when discs of like metal varying in quality are similarly treated; for example, a disc of common copper causes a lower sound than one of copper second melting, and the latter is surpassed by a disc of deposited pure copper, which produces loud sounds. From this it is believed that the strongest sounds obtained indicate superior conductors of electricity, and in order to ascertain the comparative value of (1) diamagnetic metal discs and (2) iron wires, two graduated bars formed of box wood and metal are employed respectively as follows:—

1. The bar in this case is about a foot long, graduated from zero at one end to 300 degrees at the other extremity. It is about an inch wide and 3-16ths of an inch thick, composed of two wedge-shaped pieces, one of box wood (which is graduated) and the other of *zinc*. The smaller end of the zinc is below the zero of the box wood scale. The disc of metal to be measured is placed in a suitable wooden cup on the left cylinder. The cup on the right cylinder is removed, and while the telephone is against the ear the graduated bar is passed between wooden guides over the hollow of the right cylinder until the sounds either stop entirely or a mean intensity is obtained. The degree is shown by a line on one of the wooden guides, which line faces the diameter of the cylindrical hollow of the coils at right angles to the length of the bar. As the bar moves, more zinc is gradually brought under the influence of the coils.

2. To compare samples of iron wires of the same diameter and length, to ascertain their quality as electrical conductors, a shallow cup is substituted for the preceding one, and the sample of wire laid across the top of it. The bar is graduated like that described above, and is about the same length and width, but $\frac{3}{4}$ of an inch thick. A diagonal groove extends from the upper edge of one end of the bar to the lower edge of the opposite extremity, and contains a flat bar of soft iron 1-16th of an inch thick. As the experimentalist slides the bar over the hollow of the cylinder, the distance between the iron and the coils gradually diminishes, and thus the mutual influence of the current and iron is strengthened. The readings of the scale are taken as already described.

This beautiful instrument is so sensitive that if the ends of a single ring of No. 16 copper wire be made to touch and separate, sounds are heard whenever the ring is closed; but, lastly, a molecular change in a metallic body can be made evident to the sense of hearing by, for instance, loosely supporting a soft iron wire vertically (approximately so) in the centre of one cylinder, and, by means of an adjustment, raising or lowering, carefully, a similar wire in the other cylinder until the wires counteract each other's effects, resulting in no sounds. Now take the free wire out of its support and warm one extremity in the flame of a match; on re-inserting the wire the telephone emits sounds which continue until the particles of the soft iron cool and return to their normal state. If both ends of a wire be fixed, one end, however, to a handle resembling that of a gimlet, and this wire be balanced by a second wire as before, then it is found that a slight torsion of the fixed wire produced by turning the gimlet handle is sufficient to alter the balance and create sounds.

Besides the apparatus we have dealt with many others were on view, such as single and duplex translator boards, testing appliances, Preece's semaphore block system, Umschalter switch, &c. Altogether, the exhibit was a credit to Her Majesty's Postal Telegraph Department.

The British Association.—On Wednesday next the British Association will commence its fifty-second annual meeting at Southampton. The association has met once before at Southampton, the sixteenth meeting, in 1846, being held here under the presidency of Sir R. I. Murchison, F.R.S. The great geologist had as his colleagues the presidents of the various sections—Sir I. F. W. Herschel, F.R.S.; Michael Faraday, F.R.S.; Leonard Horner, F.R.S.; Sir J. Richardson, F.R.S.; Professor Owen, F.R.S.; G. R. Porter, F.R.S.; Rev. Professor Willis, F.R.S., and Dr. Prichard—a coterie of men then in the heyday of their scientific work. This year Dr. C. W. Siemens, F.R.S., will preside, and with him will be associated the Right Hon. Professor Lord Raleigh, F.R.S.; Professor G. D. Liveing, F.R.S., R. Etheridge, F.R.S., Professor Gamgee, F.R.S., Sir R. Temple, Right Hon. G. Sclater-Booth, F.R.S., and J. Fowler, C.E., F.G.S. It may be that many look upon the giants of those days with superstitious awe, as not having their compeers in the present degenerate days, but we are fain to believe that science to-day is upon a broader and firmer footing than it was even in 1846, and that while we owe much to the great pioneers in geology, electricity, biology, &c., we have in no way degenerated, that our knowledge has increased, and is increasing at a greater rate than the individual mind can follow. We sincerely trust that the forthcoming meeting will in no way be similar to that of 1846 as regards numbers, for the latter had almost or quite the smallest number of members of any meeting. We shall be in no danger in predicting that the papers on electrical and cognate subjects next week will be far more important than those read in 1846. It will be found on reference to the report of the association that the following papers were read, abstracts of which are given in the journal:—"1. New Experiments on Electro-Magnetism," by Professor Wartman, a paper dealing with the action of magnets upon polarised light, and with electrolytic subjects. (2). Professor Mateucci read a paper entitled "Summary of Researches in Electro-Physiology," describing experiments proving that the development of electricity in living animals is a phenomenon appertaining to all organic tissues, and that it is a necessary consequence of the chemical processes of nutrition. Further, all experiments contradict the opinion of an electrical current existing in the nerves. 3. J. Bullar, M.D., read a paper on "The Identity of Certain Vital and Electro-magnetic Laws." 4. Professor Svanberg one on "A New Multiplying Condenser." 5. Mr. J. A. Brown discussed the "Results of Magnetic Observations at Makerstoun." 6. Mr. G. Fowler "Magnetic Causation." 7. W. Petrie one on "An Extensive Series of Magnetic Investigations," in which he discussed the process and material of the manufacture of magnets. 8. Rev. W. Scoresby, F.R.S., "On the Mode of Developing the Magnetic Condition." 9. J. Reade, M.D., "Experiments in Thermo-Electricity." 10. Prof. Mateucci, the "Electrisation of Needles in Different Media." 11. Rev. J. T. Robinson, D.D., "On the Influence which finely-divided Platina exerts on the Electrodes of a Voltameter;" and 12. J. P. Gassiot, F.R.S., on "The Electricity of Tension in the Voltaic Battery."

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THE BATTLE OF THE TELEPHONES.

The Postmaster-General's declaration that he intends to throw open telephonic business to public competition is likely to give rise to some complications. It is to be regretted that his meaning and intentions were not made more explicit, for it cannot be supposed that he desires to encourage a general and indiscriminate conflict among the various proprietors of telephonic patents and concessions. But unless de did mean this it is difficult to understand what was the object of making any declaration on the subject at all. A competition tempered by the veto of Her Majesty's Postmaster-General is not what we generally understand by public competition, and it would satisfy nobody. That the exercise of such a veto will be highly unpleasant for Mr. Fawcett is, perhaps, as it should be; but that public money may be spent on enterprises liable to be snuffed out at his bidding is not consistent either with free competition or with fair play.

Whatever interpretation may be put upon the official announcement, it is plain that immediate advantage has been taken of it to start fresh companies; in other words, to open the game of free competition. Evidence of this is afforded by the prospectus of the London and Globe Telephone and Maintenance Company; and the war cry that immediately followed its publication showed clearly enough the light in which free competition is regarded by the companies already in the field. "Her Majesty's Postmaster-General," say the promoters of the new company, "having intimated his intention to practically throw open the 'telephone' business, this company proposes to supply an improved and much less expensive telephonic communication than that at present in use." This is highly benevolent no doubt, but it would have been equally so without the Postmaster-General's intimation. The existing companies have had no prescriptive or exclusive rights on the ground they occupied. If they had, they are being cruelly wronged by the arbitrary cancelling of those rights. But any peg is good enough to hang one's hat upon when all the rest are occupied; and the benevolent peg of the Postmaster-General is as convenient as any other. If, however, the public are led to believe that Mr. Fawcett has purposely removed his own hat in order to make room for that of Professor Dolbear, they will certainly find themselves mistaken. This, probably, is the view which the uninformed and impulsive public will be apt to take of the proceeding, and we cannot help thinking it a most unfortunate circumstance that a misconception of this kind is likely to arise.

The several companies, however, who have had the advantage of a good start in this country and on the continent of Europe, are doing their best to remove any such impression. Here, again, we are struck by the benevolent character of the warning. The International Bell Telephone Company, the United Telephone Company, and the Edison Gower-Bell Telephone Company unite with one voice in cautioning the public against the London and Globe Company. They "think it right," in view of the prospectus issued by the last-named company, to give public notice that—that, in fact, they are the only Jones. This to the tune of half a column of advertisements in all the London papers is, it must be owned, extremely good of them, if only we could be sure of their disinterestedness. Such lavish expenditure merely in the interests of a credulous public is rare, and we do not exactly look for it in people who have just issued from courts of law, where they have been doing their utmost to prevent the public having the right of choosing their own form of telephone. On the whole, the proceeding is altogether inexplicable, unless there be any reasonable prospect of deterring the public from subscribing capital to the new concern, which in present circumstances seems unlikely. Equally improbable is it that the promoters of the new company will be frightened out of the battle-field by the trumpets of the defending host. The United Telephone Company give public notice that "proceedings will be taken against the London and Globe Company, or against any other person or company selling, using, or supplying telephone transmitters or receivers which are infringements" of their patent rights. If the force of this sentence were on a par with its ingenuity, the fate of the Dolbear telephone would be sealed; but we did not need to be told that the owners of the Edison patents would take proceedings against inventions "which are" infringements of theirs. The question is, what are infringements? And in respect to the Dolbear and Anders devices this point has still to be settled, and will not, we imagine, be disposed of by a newspaper advertisement, however cunningly worded.

Into the technical question involved in the contest foreshadowed by these manifestoes we are not inclined to enter.

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For the people in possession there is a great deal of law and not a little scientific testimony to be urged. What might be urged on behalf of the new comers has yet to appear. If Professor Silvanus Thompson's dictum may be trusted they are not invasions of Edison's patents. In his judgment the Dolbear and Anders transmitters are inventions distinct and separate from those of Mr. Edison, being based upon the principle of Reis's early telephone, which was invented in 1861. Probably this does not by any means exhaust the merits of the claim, for in one sense all telephones are based upon Reis's, though, as a matter of fact, the essential characteristic of Reis's instrument could never have formed a basis for a serviceable speaking instrument. To Professor Graham Bell, and to him alone, we owe the true principle of telephonic transmission, or more correctly of telephonic receiving. The transmission may be varied within certain limits in a multiplicity of ways, some of which bear more or less resemblance to Reis's, whilst others are mere varieties of the Edison method, his, in turn, being the application of a principle by no means new. Hence the quarrel over transmitters; and this quarrel, we fear, is likely to last so long as capital can be found to fight with. Patents for telephone transmitters are, as we have said on former occasions, much like patents for electric lights, they cover variation, but do not engross the principle; and it seems to us that, like the illuminating portion of electric lighting, the transmitting portion of the telephone, if patentable at all, should be allowed each to stand on its own merits. If one invasion is permissible, twenty are permissible; and, from the point of view of public advantage, an invasion which is at the same time a substantial improvement ought not to be hindered by the somewhat haphazard, and often mistaken, ruling of the law courts.

That the several companies themselves are dimly conscious of the justice of this view of the case, and are apprehensive that in due time it will prevail, is, we think, apparent in the course they are now taking. If they had a strong, an impregnable, position, they would hardly appeal to the public to reinforce it. Lord M'Laren and Mr. Justice Fry may not be infallible; but what is lacking in them will be found in the Postmaster-General and his scientific advisers. If the Dolbear-Anders inventions are worthless or superfluous, the Post Office authorities may be trusted to say as much; and now that they have elected to throw telephonic business open to competition, reserving still the right of withholding licenses, they will, we suppose, be bound to pronounce judgment on pretensions such as those advanced by the London and Globe Telephone Company.

THE POSTMASTER-GENERAL'S ANNUAL REPORT.

That portion of the annual report issued by the head of the Post Office relating to the telegraphs is this year unusually meagre. Nevertheless, although not sensational, the information is, on the whole, satisfactory. There has been an increase in the number of telegrams forwarded amounting to nearly two millions, bringing the annual total up to 31,345,861. The grand total for the year ending 1872—ten years ago—was only 12,473,796, a contrast which ought, we think, to satisfy the most sanguine advocates of the transfer of the telegraphs to State control. With a single and quite intelligible exception of Switzerland, England now forwards a much greater number of telegrams, in proportion to population, than does any other European country. Compared with the relative number of letters, the proportion of telegrams is not so great as elsewhere; but this only proves that we are, to use an Americanism, the letter-writingest nation going; and so long as we bear the palm in respect to telegrams and population, there can be no question as to the efficency and popularity of our telegraph administration. It is the more necessary to bear this fact in mind in view of the persistency of the agitators, who still insist that our tariff is too high. We have often shown that in reality it is not higher than that of our neighbours; but whether higher or not the figures before us prove that it is not beyond our means.

The largest item of proportionate increase in the telegraph business for the year is in rentals for private wires. The revenue from this source now amounts to £88,736, being an increase of £14,203 on the previous year, and of nearly £22,000 on the year 1879-80. During the same period the income from special wire rentals has increased almost in the same ratio, amounting at the end of the financial year to the sum of £87,233.

Searching for particulars of the force employed in the postal telegraph service, the index directs us to appendix U, page 62, but, for some unexplained reason, the information is neither there nor elsewhere to be found. We only learn that the total cost of the telegraph service is £1,440,729, a sum, however, which includes the cost of new buildings, which alone amounted to £49,851 during the past year. From causes which it is needless to enter into here the working expenses have, indeed, increased so considerably that the net revenue, £264,758, is now very little more than it was four years ago. But all the circumstances considered, this is, perhaps, not greatly to be regretted.

REPAIR OF THE PORTHCURNOW-LISBON CABLE.

We so often mention the repair of a faulty cable in our notes that the statement of the mere fact carries little idea of the task accomplished. Many repairs are easily effected, and it would be out of place to call special attention to them. We have now to record one, however, the like of which has not previously been accomplished in the history of submarine telegraphy. The Porthcurnow-Lisbon cable of the Eastern Telegraph Company developed a fault found to be in a part of the cable lying in water 2,700 fathoms deep. For several months one or two ships have been waiting a favourable opportunity to effect the repair. We understand that, though trial after trial was made during more than half a year, the weather again and again prevented the completion of the work. Patience at length brought its reward, and during a perfect calm the cable was repaired. The cable was laid in 1877, and we have seen a portion of it which was cut out, showing that the cable is almost, or quite, as perfect as it was when laid down. The galvanism of the iron wire sheathing is unimpaired and perfect. The position of the fault was lat. 44, 34 N., and long. 8, 24 W. The success of these operations reflects great credit upon the staffs of the ships employed.

Electric Light at Gainsborough.—The Brush Midland Electric Light Company, at the request of a number of the leading inhabitants of this town, who undertook to defray all expenses, have, during the past fortnight, very successfully illuminated the market place with Brush arc lamps, and also exhibited Lane-Fox incandescent lamps in the shop of one of the principal tradesmen. Both the arc and incandescent lamps were run on a single circuit from the same machine, and were proved to be under perfect control.

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CORRESPONDENCE.

WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

ELECTRICITY.

SIR: 1. I have shown in my previous letters that the earth is a mass of matter, the molecules of which have been bound together by force impressed upon them by the sun, and that, owing to the motions of the earth, the force is constantly being impressed in helical directions round the mass, with a pressure equal to many quadrillions of tons.

2. In my letter on temperature I drew particular attention to the fact that the expansion of bodies under the direct influence of the sun's force is due to the force being applied with a greater velocity than the matter is capable—owing to resistance—of transmitting; and therefore under such conditions that the force manifests its power in lines which deviate from the natural course in a degree corresponding with the resistance of the matter.

3. The mass of the earth is, therefore, always charged with force, according to the capacity it possesses of retaining the force; and any interference with the regular motion of the mass, or any *portion* of the mass, according to the laws of motion, must tend to promote acceleration of motion in a direction and with a momentum which varies with the direction and degree in which the force is diverted from its usual course.

4. If we now consider the modes in which electrical phenomena are artificially evolved, I believe we cannot do otherwise than arrive at the conclusion that electrical phenomena are expressive of a peculiar condition of matter effected, other things being equal, by the particular manner in which matter is thrown into motion by impressed force.

5. Thus *vitreous* forms of matter, such as *glass*, become electrical, and in this state attract other light bodies by being *rubbed* with certain other forms of matter.

Resinous forms of matter, such as *amber* and *sealing* wax, exhibit the same electrical phenomena when they are rubbed with certain *other* substances.

Clearly we have to consider

6. (*a*) The relations which subsist between matter and motion.

(*b*) The mode in which different forms of matter affect each other.

(*a*) With regard to motion.

7. The mass of the earth being in unceasing motion it will be well to define clearly what is intended to be conveyed by motion, having due regard to the motion of the mass of the earth, for however much ignored, this is a most important factor in the evolution of all those phenomena which are natural to the earth.

8. It is, of course, evident that when the direction and velocity of any particle corresponds with the direction and velocity of the mass, relatively to each other the two bodies are in a state of rest; consequently, a body is said to be thrown into motion when any force is impressed upon it which produces acceleration of motion in the same, or in any other direction than that which accords with the motion of the mass.*

9. It is therefore evident that every displacement in the relative position of particles must, in a degree corresponding with the extent of the displacement, be an interference with the motion of the earth, so far at least as the particles displaced are concerned.

10. By the laws of motion we therefore establish the fact that the mode of evolving electricity by friction is primarily resolved into giving a new direction to the force of the sun, as well as to the force originated by the motion of the earth, and this in a degree proportionate to the rubbing.

11. (*b*) We have to consider why two different forms of matter are conducive, possibly are essential, to the production of the phenomena.

* This explanation may be excused here as the inquiry has so large a reference to the motion of he earth

12. To make this clear, we have to consider the magnetic condition of matter, or rather the direction in which matter transmits that force, with which as a portion of the earth it is always pervaded.

13. It is well known that when bodies are suspended in the field of an electro-magnet no two forms of matter point in the same direction; and the angle which the body takes to the axis of force testifies to the direction in which the force most readily traverses the matter.

14. Crystallisation gives evidence as to the power the terrestrial forces are exerting to arrange particles in definite forms whilst they are being converted from a liquid to a solid form, the crystal being formed by particles being deposited in lines which mark the direction the force has taken.

15. It is therefore evident that the more dissimilar the magnetic character of the bodies rubbed—other things being equal—the greater will be the molecular disturbance resulting from the rubbing motion; for the forces which are natural to the matter (in consequence of the motion of the earth and the influence of the sun traversing the matter in given directions) must offer resistance to the artificially impressed force in proportion as acceleration of motion, induced thereby, differs from, or accords with, the direction of the force natural to the matter.

16. The next point which demands attention is the condition of electric bodies as regards their power of conducting impressions.

17. If we review the substances that are termed electrics, we find that all of them are bad conductors of impressions. With some few exceptions they are devoid of water in a free state; for the most part the structure of all is light, and the particles are loosely combined.

18. We consequently perceive that any disturbance of equilibrium which has taken place on the surface of such bodies, as a consequence of the friction of two dissimilar forms of matter, must tend to remain in the same condition, until balance of power can be restored through a badly conducting medium.

19. I have said that balance of power would be disturbed during the process referred to above. A little explanation of the phrase "balance of power" may not be out of place here. That which I desire to convey is that the forces of action, and reaction, are, as it were, separated during the rubbing; in fact, all friction is expressive of action and reaction, for the matter thrown into motion corresponds with a like degree of impressed force; and this is met by a like force in the resistance of the matter rubbed. The former, of course, is the action, the latter the reaction.

20. A clear apprehension of these conditions is very important, and is, indeed, essential before we can understand the mode in which the artificial motion originates the phenomena of *electrical* attraction and repulsion.

21. We next ascertain that when bodies have been once attracted, either by excited glass or excited resin, they will not be attracted by the same substances again, but will be repelled by them, until they have touched some body in conducting communication with the earth.

22. When we duly recognise the intimate connection which subsists between every form of matter of which the earth is composed and the forces of action and reaction which always pervade the matter, that the helical direction of these forces is varied by the conditions of the matter, and the mode in which electrical phenomena are elicited, all mystery vanishes as to the cause of these peculiar manifestations in the phenomena of electrical attraction and repulsion, for the phenomena are resolved into exhibitions of power, of the same nature as determines attraction and repulsion in *magnetic* bodies; the attraction marking—as I have demonstrated—a disposition of two helical forces of the same denomination to move into each other, and so to combine the particles of matter with which they are associated, whilst the repulsion is due to two helical forces of dissimilar denominations working against each other as oblique forces.

23. We next observe that bodies which have been attracted by excited vitreous substances and are then repelled by them are attracted by excited resinous substances; and that the

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order of the phenomena is reversed upon reversal of the excited bodies.

24. The cause of these phenomena is undoubtedly very bewildering until viewed by the light which is capable of being thrown upon them by my experimental demonstrations, showing the varied motions of a magnetic needle point when placed on the pole end of a bar magnet, and subjected to the action of another magnet moving towards it.* The cause then becomes clear enough, for the helical motion of the needle point to the right or left may at any time be reversed at the same point of the magnetised bar by shifting the position of the moving bar magnet, and thus changing the direction of the impressed force.

25. In the electrical phenomena under consideration, the forces of action and reaction, more especially on the surface of bodies, have been disturbed, and being static forces—as far as any force can be said to exist in that condition—of but small quantity, and insulated from the mass of the earth, have but little influence to re-effect equilibrium; for their power to restore equilibrium must depend, other things being equal, upon the *quantity* of force disturbed; consequently, when the direction of the helices has been reversed, under the influence of an opposed force, the direction of the force is retained, and the phenomena of attraction and repulsion continue so long as the balance of power remains disturbed.

26. The point of dissimilarity which exists between magnetic and electric phenomena is capable of complete explanation by reference to the different states in which the two forms of matter exhibiting the phenomena exist as regards insulation. Thus, in the electric state attraction or repulsion is capable of being manifested so long as the condition of the force remains; but in magnetism it is different, for no insulation exists, but the magnets are reservoirs of the earth's force, which owe their power to acceleration of motion in a direction opposed to the motion of the earth. The needle point therefore regains its original direction upon the removal of the opposing magnet, and the phenomenon is capable of being repeated at will, as I have fully shown in a former paper.*

27. In proof of there being one current or force moving in one direction only, great stress has been laid upon the fact that the flame of a candle when exposed to a discharge of electric force is bent in the direction which the discharge takes; and the behaviour of the flame under such conditions gives *prima facie* evidence in favour of the theory. But when we closely investigate these phenomena, and subject the force to the laws of motion, so far as stress or action and reaction are concerned, we find that the bent position has been given to the flame by the direction of the action which is the *primary* force. It is then, while in the bent position, traversed by the force of reaction, which, being equal and opposite to the action, also tends to maintain the bent direction of the flame.

28. I believe I have now proved by reference to the laws of motion—

1st. That the manifestation of electrical phenomena is always dependent upon an interference with the force of the sun and the motion of the earth.

29. 2nd. That by the friction of two dissimilar forms of matter, the potential energy or force of the earth, which has been acquired from the sun, and which attaches to those two bodies as portions of the mass, is superficially disturbed, and by a process of analysis is temporarily resolved, as it were, into action and reaction.

30. 3rd. That the attraction which is manifested by a glass rod or a stick of sealing wax for the rubber is due to a disposition of the two conditions of force to recombine by similar helical motion, precisely as occurs in the phenomenon of magnetic attraction.

31. 4th. That the repulsion which is exhibited under certain other conditions is due to dissimilar helical forces acting upon each other as oblique forces from the same direction, as shown in the phenomenon of magnetic repulsion.

32. 5th. That all manifestations of electric force are necessarily associated with the matter upon which the force is acting, that the phenomena vary with the condition of the matter, and are always accompanied by action and reaction, that is by motion in two opposite directions.

33. It will be well now to consider the relations which exist between electricity as artificially produced in the manner described, and that which is naturally exhibited in the phenomena of a thunderstorm.

34. We are well aware that thunderstorms are frequently, although not necessarily, preceded by great heat and dryness of the atmosphere, conditions which are the natural concomitants of friction and acceleration of motion in a direction more or less at right angles to the direction of the earth's motion; consequently, we have here a natural development of electric force upon the same principle as we have seen it artificially produced. For although electrical storms occur in the winter and under low temperature, we may rest assured that the equilibrium of the forces due to the action of the sun and the motion of the earth has been disturbed by wind or some other mechanical motion acting in opposition to them, and that by some such means the locality of a thunderstorm has been converted into an electrical centre, of which centre the mass of the earth is in one condition, and the adjacent atmosphere in another, of static charge.

35. It is evident that as centres of force these two conditions of force, in accordance with the third law of motion, are attractors as well as radiators of force, and, therefore, of matter also, and although this principle at first may appear somewhat unintelligible, it becomes clear when we remember that the momentum of those waves of motion take their origin in the force of the sun and the motion of the earth. We then perceive that as in rise of temperature, so in manifestations of electricity, any acceleration of motion in any direction, if opposed to the motion of the earth, is bound to act as one of three factors in the local accumulation of energy, for by the polygon of forces any element which disturbs equilibrium is bound to become an accumulator of energy, just in proportion to the equilibrium it disturbs. It is, in fact, by this means that the matter is accumulated which forms the thundercloud.

36. We also ascertain that when the static charges in the mass of the earth and in the atmosphere are able to overcome the resistance of the intermediate badly conducting media, the charges are equalised, and the force manifests its momentum upon the intermediate matter. Provided this be a good conducting medium, such as a copper wire lightning conductor, the charge in the earth and the charge in the cloud restore equilibrium slowly but surely through the wire, and the aggregation of particles forming the cloud may be dispersed; but, in the event of no such medium existing, then the force displays its energy upon the particles of matter which intercept its course, and with which it is associated. If these be aqueous they are combined, and drops of rain result, which vary in size with the power of the condensing force, and these again are capable of being further compressed by a yet more active force into lumps of ice, upon precisely the same principle as ice is formed at the poles of the earth.

37. The synthetic formation of water by the condensation of two gases into a liquid, under the influence of the electric discharge, demonstrates the principle to which I have referred as the cause of the formation of rain and hail; and as under that process considerable reduction of temperature is experienced, we know that cold is not the cause but the effect of the discharge.

38. This principle, in fact, applies to all rainfalls, for just in so far as upper layers of cloud intercept the dispersing power of the sun's force, they tend to reduce temperature, to restore equilibrium, to promote condensation, and induce matter suspended in the atmosphere to gravitate to the earth.

It is my intention in future papers to show, by the laws of motion, more particularly than I have done, the mode in which the force of the sun and the force of the earth correlate into chemical action, crystallisation, and animal and vegetable life.—Yours, &c., RICHARD R. SHETTLE, M.D.

Reading, July 14, 1882.

* *Vide The Electrician*, June 25, 1881.

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THE FYFE-MAIN AND THE CROMPTON LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Being a reader of your paper, and taking great interest in the patent arc lamps as the specifications are published, and noticing your illustration and remarks in last Saturday's number regarding the Fyfe-Main lamp, I should be glad if you would kindly state for my information in what respects the above lamp is similar to the Crompton.—Yours, &c., C. S.

13, Lorne-road, Finsbury Park, 16th August, 1882.

"ELECTRO-EGOISM."

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Some of the most popular and prolific members of our profession have for some time past been afflicted with an epidemic, which I have ventured in the interest of electro-therapeutics to name "electro-egoism." The diagnosis of the disease is well defined. It is necessary for the full development of the complaint that the subject be an inventor—then in the brain, at least of those subjects as have shown the disease in its must virulent form, appears a tumour firmly encysted, but susceptible of occasional outbursts or ulcerations. The cause of the tumour appears to be an irritation of a local character, chiefly, it is strange to say, a formula of words, viz., "I am the first and true inventor thereof." But the curious part of these cranial phenomena is that the word "thereof" is not meant by the patient to include his own property, but relates to that of his dead and gone ancestors, or even of others not his ancestors. This peculiarity is so strongly marked as to make it of importance to ascertain whether a ward in certain public hospitals should not be opened to receive such patients.

I will instance a few subjects in this new disease. As is usual in the annotation of medical cases, to save the feelings of the patient, names are omitted.

—— invented an improvement in incandescent lamps. These improvements were of the greatest importance, but, nevertheless, more closely related to those of dimensions than of novel application. For certain of these improvements, not one of which embodied the discovery of more than useful details, yet be it admitted details that were necessary, letters patent were obtained, and the disease commenced. For several years it showed signs of sturdy development, and at last, somewhat recently, the climax has arrived. A singular concurrence with the climax is the fact that somewhat similar inventions to those of the patient have been made by others, who have not yet, however, manifested forms of the disease, at least, in no greater amount than may be said to be due to the aberration of any inventor. I forget now whether the improvement in the case of this particular patient related to the fastening of the fibre with a screw or without a screw, or whether it was to an improvement in obtaining greater vacuity (I mean in the glass bulb), but it was of this class of improvement (for which I assume patent laws will be limited in some more enlightened age). But the climax is lamentable. There is now actually claimed by the sufferer that a band or filament, irrespective of material, made incandescent by an electric current, is his invention. To listen to him one would almost imagine there had occurred one of those cataclysms, so ably invented by Jules Verne, by which the whole literature of science had been "wiped out," including the researches more particularly of Chanzy, Moses G. Farmer, Haite, and Petrie, and many others. Even we know that Konn, Starr, Boulyguine, and others used a carbon rod *in vacuo* a many years ago, so long ago that some of these inventors are dead and gone, yet the mania is now to claim a carbon filament in a vacuum. What is a carbon rod but a larger filament, and a vacuum but a vacuum, although made with a better pump? And do the patent laws of any country give an inventor the right to patent improved dimensions? And does the discovery of the best dimensions give one the right to claim all antecedent inventions of this class? Such are the questions that sufferers from the disease seek to answer affirmatively.

It has been pointed out to me that an exhibition in strong doses of *Annalen de Chemie et de Physique*, Vol. XXIX., August, 1825, would meet all such cases, but I have not been able myself to verify this prescription.

The subject would be more grave if it were not that lunacy is so thoroughly apparent in threatened law proceedings.

I would suggest, in order to avoid all personality by which the identity of the patient could be established, that I could indicate several other cases relating to telephones, dynamo-machines, plating solutions, and the like.—Yours, &c.,

Paget Higgs.

CITY AND GUILDS INSTITUTE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Perhaps a word upon your recent editorial article under the above title may not be out of place.

As regards the falling off in the number of candidates in telegraphy, the reason is perfectly obvious to the initiated. I understand that in the Postal Telegraph Department the determination has been arrived at that, in the matter of advancement, technical excellence shall have no claim over technical mediocrity. In the face of this decision it would be quite irrational to expect the operators to spend time, money, and labour (any one of which they can ill-spare) on a course which they are distinctly led to believe will bring them no return.—Yours, &c., Stonefield.

August 12, 1882.

SWAN OR EDISON IN AMERICA.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The article, "Swan or Edison," which you print this week, is doubtless very interesting, as showing all the world how Edison's sharp lawyers mean to keep Swan from using a lamp which neither he nor Edison invented, but which both of them have done a great deal to improve. If any of your readers imagine that the conclusions of Edison's American lawyers are likely to be accepted in a British court (where not only different patent laws, but different patents are in question) they must, indeed, think patents and patent laws to be a hopeless bewilderment. Edison's first claim (p. 304) for "an electric lamp having a continuous conductor (without having regard to its material, resistance, or mode of preparation), and an exhausted enclosing globe," is a fair sample of the kind of "grabbing"—there is no politer word available—of which too much has, unfortunately, been seen of late. To claim as new an invention nearly forty years old, and to put it in the forefront as a broad claim, is too palpable. Such a claim, if brought into an English law court, would ruin the claimant's case. Take, again, the fourth claim, which purports to be a claim for a "method of manufacture." It is nothing of the kind. It is a claim for doing certain things in a certain order. To claim as a patented privilege the right to form the globe before you put the carbon into it and seal it up is too absurd. It is like patenting the right to dip your pen into the ink before you write with it. I have not yet heard that Edison has added this to his claims. When this fourth claim has been substantiated in an English law court, I shall begin to believe that "the broad principles covered in the above named *fundamental* patents allowed to Mr. Edison are *so exclusive* that it is not too much to say that neither Swan nor any one else has made or can make a successful incandescent lamp without infringing *every one* of the above patents"—*but not till then*.—Yours, &c., No Side.

August 12.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In regard to your issue of August 12, Mr. Edison claims to be the first inventor of an incandescent lamp, which Mr. Swan more honestly does not. The patents granted to Mr. Edison, namely, Nos. 223,898, 227,229, and 230,255, are not valid for several reasons, namely, King, of London, in 1845, tried carbon for incandescent lamps; also Konn, of St. Petersburg, which were enclosed in a glass globe from which the air was exhausted. With regard to the fitting for the

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lamp, why not patent a chandelier with holes screwed for burners to screw in to, or a piece of gas-pipe to be fixed with hooks?—Yours, &c., F. L. WILLAN.

25, Richmond-street, Aug. 12, 1882.

THE GERARD SYSTEM OF ELECTRIC LIGHTING.

It is becoming somewhat difficult to remember the distinctive features of each separate lamp, and the more so as most of them differ in the mechanical arrangement and not in principle. We have no doubt that the most self-satisfied lamp maker would feel a little dubious if he were asked to name the best lamp for burning paraffin, or colza, or any other oil, and we are beginning to feel that electric lamps are somewhat similarly placed. Who will undertake to say which is best? And yet the question is put to many of us daily, nay almost hourly, and gentle anathemas are uttered because the answer is somewhat equivocal. It is said that a southener always answers a question by asking another, and when a native of New Orleans was asked the truth of this, he replied "Does he?" How often one blesses that southerner when the question comes out, Now, which *is* the best lamp? and the answer goes forth, What for? The value of a lamp depends much upon the "what for?" even when the questions of simplicity and economy have been settled.

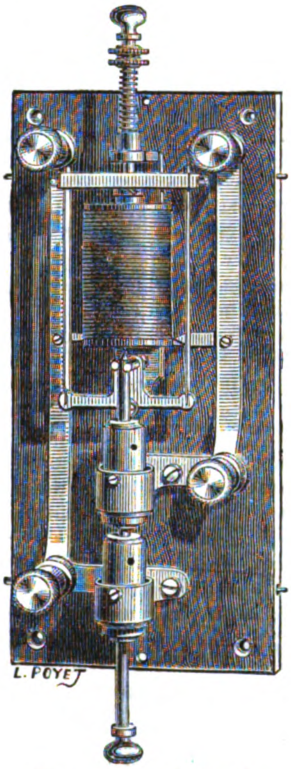

FIG. 1.—Gerard Cut-off.

The foregoing will partially answer some of our friendly critics who wish a comparative value labelled on every lamp described.

The Gerard system was to be seen in part of the south end of the nave at the Crystal Palace, in the China and Glass Court, and near the company's shed in the south-east corridor. The lamps employed were of two kinds, which differ considerably in appearance, but are essentially the same in the mode by which the arc is regulated, viz.:—The Gerard alternate current, 2,000 candle lamp (nominal), and the Gerard small slide lamp of 1,000 candle-power (nominal). Besides these two classes of lamp the firm exhibited at their stand a modification of their large lamp, suitable for a rather less intense light. The principal exhibit, which was in the Grand Nave, consisted of six of the large lamps, suspended three on each side from iron posts, as they would be for street lighting, while in the China Court two of the same kind were hung from the roof. Every shade of colour in the various descriptions of glass ware was seen perfectly. The lamps, like various others, are suspended by a chain and counterweight, and when lowered for examination reascend of themselves to the proper height.

The eight lamps were arranged in two series of four each, and were fed from a two circuit alternate current machine, making 700 revolutions per minute. The machine was excited by a separate exciter, and the two together, we are informed, absorb about 10 h.-p.

Messrs. Gerard and Co. had also eight additional lamps of the large type arranged in series in the nave, but as the large galloway engine belonging to the Palace, from which the dynamo-machine for these should have been driven, was being worked to its utmost capacity, they were only able to show these extra lights when other exhibitors did not require their allotted power.

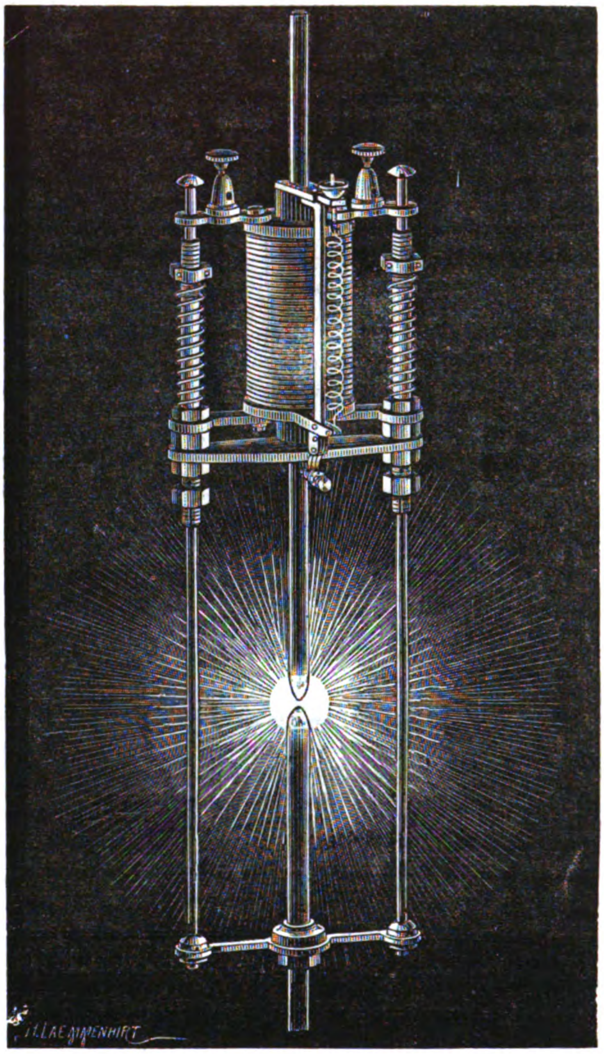

FIG. 2.—Gerard Arc Lamp.

The lamps being used in series it is necessary to have an arrangement to cut off the current from any lamp that may be injured. The peculiarity of the "Gerard automatic cut-off" (Fig. 1) is that it has mercury contacts, and is not, therefore, liable to failure through oxidation. When the resistance of any lamp becomes, from any cause, too great the armature of an electro-magnet in a shunt circuit of 1,000 ohms is attracted, and allows two iron plungers to fall into mercury cups, and thus short-circuit the lamp. The action of the "Gerard cut-off" is instantaneous, and thus causes no observable flicker in the other lamps on the same circuit.

The Gerard lamp is simple, and the mechanism is placed above the carbons, an arrangement which has the advantage of reducing to a minimum the parts which cast a shadow.

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The regulator in the case of the large lamps is composed of a frame formed of two vertical rods and cross pieces which support a straight electro-magnet, the core of which is hollow, to allow the upper carbon to pass freely through it (Fig. 2). This electro-magnet is wound with fine wire and is placed on a shunt circuit between the terminals of the lamp. A jointed brake, carrying a screw which presses against the carbon, holds it and prevents it from falling; the pressure of the brake against the carbon is regulated by a spring. This brake carries an armature on the upper part, and when this armature is attracted the brake releases the carbon and allows it to descend.

The lower carbon is supported by a movable vertical frame, the upper part of which carries an armature placed near the lower extremity of the electro-magnet.

The apparatus works thus: When the current is sent through the lamp, the carbons are apart, and it can only pass through the electro-magnet, which is thus brought into action and attracts the two armatures, the upper and the lower. The upper armature acting on the brake releases the upper carbon and allows it to descend. The lower armature raises the lower carbon and its frame. As soon as the

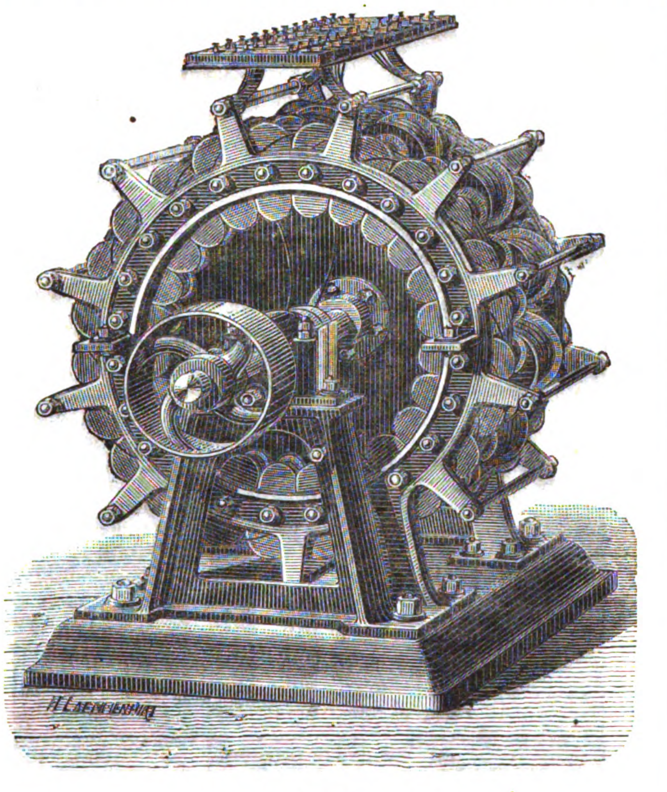

Fig. 3.—Gerard Dynamo.

two carbons are in contact the current which passed through the derived circuit is in a great measure weakened. The lower armature falls, carries with it the lower carbon, and strikes the arc. The upper armature carrying the brake is in part released, and the screw begins to press against and hold the upper carbon. If the spring is properly regulated there is equilibrium, but, as the carbons are used, the arc tends to lengthen, and the power of the current in the electro-magnet on the shunt circuit is increased. The brake is thus taken off more and more by reason of the vibrations of the armature, the upper carbon gradually and imperceptibly slides down, maintaining a constant and steady arc. The apparatus is said to work with great regularity and with satisfactory steadiness.

Messrs. Gerard and Co. also exhibited in the south-west corridor 12 "slide" lamps of 1,000 nominal candle-power each. These are so simple as to be apparently wanting in all effectual modes of regulation, but seem to burn with great steadiness. The principle is the same as that employed in the lamps just described.

These 12 lamps were worked from one Gerard alternate current dynamo machine (Fig. 3). The peculiarity of this machine is that the inducing electro-magnets are made to revolve between fixed armatures, which have thin sheets soft iron placed between the layers of the wire, and also a solid iron plate at the back. This arrangement of fixed armatures does away with the necessity for a commutator or "brushes" to collect the current, the ends of the armature coils being simply brought to terminals on the top of the machine. This enables the armatures to be joined, so as to run lamps either in series, parallel arc, or separate circuits, as may be desired. For factory use, a purpose for which these lamps are specially adapted, the possibility of arranging several lamps on single circuits from one machine is a great advantage. The dynamo machine for twelve lamps makes 750 revolutions per minute. It is worked with a separate exciter, the two machines, it is said, taking together about 8 h.-p.

All the Gerard Company's lamps can be adapted, with a slight modification, for use with continuous currents.

The following report, by Professors Ayrton and Perry, upon the Gerard installation, which has been placed at our disposal, will be of interest:—

"We have examined an alternate current small Gerard light, forming one in a series of ten worked by a Gerard dynamo, as well as a large Gerard lamp, one of a series of eight, also worked by a Gerard dynamo. In both cases the actual horse-power given electrically to the arc was measured, and the illuminating power of the lamp at various angles when the lamp was above as well as below the photometer.

"The lamps were examined through green glass as well as through red glass, so as to compare the green rays of the electric light with the green rays of the standard candle, and the red rays of the electric light with the red rays of the standard candle.

"The results obtained from a long course of experiments were as follows:—

Large Gerard Alternate Current Lamp.

Angle.	Illuminating Power. Red.	Illuminating Power. Green.	Mean.	Horse-power actually expended in the arc.	No. of Candles per Horse-power actually expended in the arc.
33°	531	1,032	781	0·50 to 0·73	1,200 to 1,986
50°	665	2,235	1,450		
57°	470	767	618		
0°	576	1,117	846		
*43°	525	1,986	1,255		

*43° means that the lamp was below the photometer.

Small Gerard Alternate Current Lamp.

Angle.	Illuminating Power. Red.	Illuminating Power. Green.	Mean.	Horse-power actually expended in the arc.	No. of Candles per Horse-power actually expended in the arc.
Horizontal	400	1,377	888	0·3	2,960
45°	244	491	367		1,223

"The light was steady.

"We do not know whether you expect with these measurements to receive our opinion as to the construction of the lamp. There can be no doubt that it is one of the simplest in construction; probably it is simpler in construction than any lamp now in practical use, and we do not believe that this simplicity of construction is gained by a loss of power of regulation.

"The Gerard lamp and the method employed for automatically adjusting the distance of the carbons are very simple in construction, so that this lamp is very suitable for factories, streets, or other places where many arc lamps are required and when much attention cannot be given to them.

(Signed) { "W. E. Ayrton.
"John Perry."

Bordeaux.—The Siemens arc lamp and the Edison incandescent lamp are attractive features of the Bordeaux Exhibition.

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EXAMINATION QUESTIONS.

Questions set at the recent examinations of the City and Guilds of London Institute for the Advancement of Technical Education.

22 B.—ELECTRIC LIGHTING AND TRANSMISSION OF POWER.

Ordinary or Pass Grade.

[Candidates are not expected to answer more than *six* questions, but more may be attempted.]

1. Explain fully why at the present day it is more economical to light large rooms with the electric light than with gas, and why this was not the case some few years back.

2. What is the principle of a dynamo machine? Explain in detail the construction of the dynamo with which you are best acquainted, describing the nature of the material (soft iron, cast-iron, or steel, &c.) employed in each part, and giving full sketches illustrating the mode of winding the coils, and the size and shape of each part of the machine, as well as the reasons, as far as you know them, for the method of manufacture employed.

3. Explain fully, with sketches, how dynamo machines of the Brush type differ from those of the Gramme. What are the relative advantages and disadvantages of direct and alternate current dynamos?

4. A joint has to be made between the ends of two thick electric light wires. Explain, and give sketches of, the method of jointing you would employ. In carrying wires, between which there is an electromotive force of 300 volts, through the rooms of a building, what method of insulation would you make use of? Show exactly how you would lead the wires to a number of incandescent lamps suspended from a bronze chandelier, and give the reasons for adopting your method.

5. How many feet, about, of copper wire $\frac{1}{20}$th of an inch in diameter have one ohm resistance at 60deg. F.? About how much per cent. is the resistance of copper wire altered by an increase of 15deg. F. in the temperature, and is the resistance increased or diminished.

6. What is the electromotive force in volts of a Daniell and of a Grove cell? What is the electromotive force of the dynamo you are best acquainted with, running at some definite speed, and with some special resistance in circuit? How exactly is this electromotive force altered by increasing the speed? In the case of a magneto-electric machine how does the electromotive force vary with the speed? Explain fully the cause of the difference, if any, in the effect of speed on electromotive force in the dynamo and in the magnetic machine.

7. A certain magneto machine when running at 500 revolutions a minute, produces an electromotive force of 8 volts, what current in amperes will it send through an external resistance of 50 ohms when running at 750 revolutions a minute if its own resistance is $1\frac{1}{2}$ ohm?

8. What are the essentials of a good electric lamp? Describe, and give sketches of, the lamp which you consider most nearly fulfils all the conditions necessary for good working. How does a lamp for reverse currents differ from one for direct currents? What also is the difference between the carbons employed in the two cases?

9. Describe in detail the construction of the incandescent lamp you are best acquainted with, and explain how the various types of incandescent lamps differ from one another.

10. A Grove battery of 20 cells will light from one to twenty ordinary incandescent lamps in parallel circuit, but the *fewer* the lamps the *more* the light given out by each. On the other hand a Gramme machine will not light one ordinary incandescent lamp at all, but will light twenty or thirty well. Explain fully what this difference depends on.

11. What is the principle of a photometer? What form of photometer is most suitable for use with strong electric lights? What sort of results are obtained for the illuminating power of an electric light when it is examined through green and through red glass respectively. How does the intensity vary for beams at different angles in the same vertical plane for arc lights, and for incandescent lights, first, when a continuous current; second, when a reverse current is employed.

12. Describe with sketches the construction and action of any instrument you are acquainted with for measuring strong currents. What are the currents in amperes used respectively in the various systems of electric lighting?

13. Why does a spark occur in breaking the circuit of an electric lamp? Give a sketch of a switch so constructed that the spark on opening the circuit is very small. Why does no spark occur on closing the circuit?

14. Explain in detail how electricity can be used for transmitting power, and how by its employment sources of power at present wasted may be practically utilised.

15. How can the direction of rotation of a dynamo used as an electromotor be reversed. Why ought an electromotor not to be attached to the axle of a tramcar, and drive the wheels directly without the employment of speed reducing gear?

Honours.

[Candidates are not expected to answer more than *seven* questions, but more may be attempted.]

1, 2, and 3. The same as in the Pass examination.

4. Draw the "characteristic curve" of a dynamo, and explain what are the various practical uses that can be made of it? Explain in detail the experiments you would carry out to enable you to draw the characteristic curve of a special machine.

5. Draw the "characteristic curve" of a magneto-electric machine, and compare the advantages and disadvantages of dynamo and magneto machines.

6. Given the "characteristic curve" for a dynamo running at 500 revolutions a minute, as well as its resistance, show how you can ascertain at what speed it must run so that a current of 1·3 ampere shall flow through each of 30 incandescent lamps in parallel circuit, the resistance of each lamp for that current being 42 ohms.

7. How does a "shunt dynamo" differ from a "series dynamo?" Explain fully their relative advantages and disadvantages. Give examples showing the resistances you would employ in each case for the field magnets and for the armature.

8. Define an ohm, a volt, an ampere, and a coulomb. A certain magneto-electric machine with an armature of $\frac{1}{2}$ an ohm resistance, from brush to brush, running at 800 revolutions a minute, produces an electromotive force of 30 volts, what current would this machine send through a wire having 1,000 ohms resistance, if the armature were wound so as to have 5 ohms resistance, and were revolved at 1,300 revolutions a minute?

9. Describe the construction and action of various forms of speed counters for use with dynamos.

10. You are required to ascertain the efficiency of a dynamo. Describe in detail the experiments you would carry out for this purpose.

11. What are the essentials of a good electric lamp? Describe and give sketches of the lamp which you consider most nearly fulfils all the conditions necessary for good working. How does a lamp for reverse currents differ from one for direct currents? What also is the difference between the carbons employed in the two cases?

12. What is the principle of a photometer? What form of photometer is most suitable for use with strong electric lights? About how much per cent. are English "standard candles" found to differ? Describe Vernon Harcourt's light standard. What is your experience of the relative penetrating power of gas and of the electric light in a fog? Explain what you think is the cause of this result, and in what way you would propose to increase the penetrating power of the electric light.

13. Describe in detail, and give sketches of the instruments employed for measuring large currents and large electromotive forces, 1st, when the currents and electromotive forces are continuous; 2nd, when they are rapidly reversed. Compare the relative advantages and disadvantages of the various forms of instruments.

14. How is the current flowing through any circuit, and the electromotive force, maintained between its ends connected with the horse-power expended in the circuit? Describe an electric power meter for measuring from one observation the horse-power electrically expended in a circuit. Give a full account, with sketches, of the experiments you would make to measure the number of candles produced per horse-power expended in an electric lamp. Give the results of any experiments that have been actually made, showing how this efficiency of a lamp varies with the work electrically done in it.

15. Describe methods of ascertaining the exact connection between the speed of the generator, the speed of the motor, the resistances of the machines and of the connecting wires with the efficiency obtained in the electric transmission of power.

16. Given the resistance of the generator and motor, and of the line wire per mile, calculate a formula which tells the amount of power lost from the heating of the wires when a certain amount of power is transmitted over a certain number of miles. Apply your formula to several numerical cases.

17. What is meant by the "efficiency of an electromotor." Explain in detail and give sketches of the method you would employ to measure this efficiency. Give the results that have actually been obtained with magneto and with dynamo machines used as motors.

18. In what case would you recommend the employment of water transmission, and in what cases electric transmission of power?

19. Describe, with sketches, the methods in detail of using a

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secondary battery to make an electric light independent of fluctuations in the speed of a dynamo, 1st, when the generator is a "series dynamo;" 2nd, when it is a "shunt dynamo."

20. Explain how the very high potential necessary for obtaining economic electric transmission of power can be practically employed by the use of secondary batteries.

21. What are the advantages of electric railways over the present system of railway propulsion? How much per cent. of the total power given by the engine to the generator could you anticipate would be lost altogether in an electric railway 50 miles long, worked with ordinary Gramme dynamos, taking into account the mechanical friction in the generator and motor, the heating of the wires from the passage of the current, and the leakage arising from the day being damp, and the rails through which the propelling electric current is conveyed resting merely on the ordinary wooden sleepers.

ELECTRIC CARBON STORAGE AND APPARATUS MANUFACTURING COMPANY OF SCOTLAND.

The statutory meeting of the shareholders of this Company was held at the City Terminus Hotel, Cannon-street, on Wednesday, Mr. W. P. Hope in the chair.

Mr. Ernest Terraneau (secretary) read the notice convening the meeting.

The Chairman said: Gentlemen—You have heard the notice convening the meeting, and it pretty well explains the cause of this meeting. It is simply the statutory meeting to fall in with the law of limited liability companies, and finding myself in the chair here in the absence of our chairman, Mr. Ratcliffe, I have to explain that we have got possession of the premises at Leith. We have been, during these last three months, busily getting the necessary tools placed in the premises, and we are now partially manufacturing carbons in the hope of being able to begin the manufacturing of dynamos and lamps within a few weeks from this time. We have got 171 shareholders upon our list, holding 23,117 shares. The applications for the shares of this Company, coming out late, when the electric *furore* was at its height, or, rather, afterwards, were not so successful as we had hoped; but although the applications were smaller than we had anticipated, they were sufficient to warrant the directors in going forward to allotment, especially as they had an offer for the purchase of the Storage shares which formed part of the property that was to be handed over to them at a price which they considered to be sufficient to induce them to part with them at once. Having made arrangements for the settlement of the property satisfactorily to themselves, and having assurances of having sufficient capital available for any possible extension of their business, they considered that it was wise on their part to go to allotment, and in the meantime to go on with a capital which is comparatively small as compared with the sum that was to be issued, watching the progress of electricity; watching the future of it; believing that we have a great deal yet to learn; believing that there is a great deal we do not know to-day that we may know in a month two hence. We have no expensive patents; we have no sums of money due for any system; we are simply waiting with a well-organised manufactory to take advantage of the time when we believe the best electrical machinery will be before the public, and then we mean to go forward manufacturing the same. These are the objects of the Company, Gentlemen, and I believe I am safe in saying that so far as we have gone in the production of carbons we have succeeded in producing an article at least as good as anything that has yet been before the public. The prospects of the Company are at this moment very assuring. We have proposals from the Continent and from many parts of this country for the manufacture of plant whenever we are in a position to take them up, and there is a good demand for electrical appliances such as we aim at producing, namely, cheap articles, which, though not perhaps so highly efficient as some others, may answer their purpose as well, and which, we believe, will be more applicable and acceptable to the public. We are going in more for producing cheap electrical appliances, and I believe that when we are in a position to go to the public we shall have as much work as we have the means of undertaking. Those companies that have come before the public lately have savoured very much of the kind of companies that the Stock Exchange has more interest in than the company that I am now talking about. The Stock Exchange quotation which we indicated in our prospectus that we should apply for, we do not, of course, in the meantime intend to move for, seeing that our capital is not sufficient; but I can say this much, that those who have invested their money in this Company will, with a little patience, find, I believe, that they have something far better than a stock that will be bought and sold at the price of the day. I have the greatest expectation that the results of this Company will be very satisfactory. I do not know, gentlemen, that I have anything further to tell you. I am sorry that, owing to the delay that has taken place in placing our machinery, we have more to point forward to what we intend to do than anything we have done; but I hope when we meet you again that we shall be able to put before you something more tangible and satisfactory. If there are any shareholders present who would like to look at the carbons we have produced they are here for that purpose, and they are here at the disposition of any shareholders. I may also say that if there is any gentleman who would like to have further information we shall be delighted to answer any question that may be put.

Mr. Rosenthal: Mr. Chairman—I should like to ask whether any offers have been received that are in course of execution?

The Chairman: I think I stated that we are not in a position to receive any orders in consequence of the delay that has taken place in fixing our plant, but we have a number of inquiries and negotiations going at present which warrant us in saying that whenever we are ready we have abundance of work waiting for us.

Mr. Rosenthal: I understand from the remarks you have made that the capital subscribed at the present time if called up would be about £14,000. Now, I remember in the prospectus it was stated that a large sum—I believe something like £20,000—of which part was to be given in shares, was to be paid to vendors. Allowing for this, I do not know whether arrangements have been made for the payment of the amount or any part of it at once; but, assuming that only part of it is to be paid, would there be enough capital remaining to carry on the business with the intention of manufacturing electrical plant, such as dynamo machines, and other electrical appliances of a more spacious and heavy kind than the carbons proposed to be manufactured? I should be obliged for information on that point.

The Chairman: I am very glad to be able to give the information asked for on the subject. You must have overlooked what I stated before—that the directors are satisfied that the arrangements made give us ample capital, not only for carrying on our business just now, but to meet any extension of trade possible for the next twelve months. The arrangements on that point are perfectly satisfactory to the directors. There has been no money paid yet for the property; but the directors had sufficient response to enable them to go on with the capital we now have.

A Shareholder: There is nothing special in the carbons, is there?

The Chairman: Carbons are all very new, but I do not think you will find that any company is manufacturing carbons here excepting ourselves. We are already promised by several companies that as soon as we are ready to supply them they will take all their requirements from us, and I have not the slightest hesitation in saying that we shall be able to dispose of every carbon we can make.

Mr. Fraser having mentioned that the Company had for its object the manufacture of materials to be used by other companies, moved a vote of thanks to the chairman.

The motion having been adopted, the Chairman briefly returned thanks, and the meeting closed.

THE BRUSH ELECTRIC LIGHT AND POWER COMPANY OF SCOTLAND (LIMITED).

The first general meeting of this Company was held on Wednesday at the Cannon-street Hotel, the Hon. Ashley Ponsonby in the chair.

Mr. Fred. M. Brocklebank (the secretary) having read the notice convening the meeting,

The Chairman said: Well, gentlemen, I have not very much to say to-day. This is the statutory meeting held in conformity with the Act, but I am very glad we have an opportunity of meeting you, because there may be questions which you would like to ask, and which I shall be happy to answer to the best of my ability. I may tell you that the Brush Electric Light and Power Company of Scotland was incorporated on the 25th April this year, and the issue was made to the public on the 27th, with a capital of £300,000 in 60,000 shares of £5, of which the first issue was £150,000. 8,000 shares were reserved in part payment for the concession to the vendors, and the remainder was offered to the public, namely, 22,000 shares. In a company of this kind there has hardly ever been so large a subscription, and when I tell you we had 2,200 shares to offer to the public, and we had subscribed for 377,553, you will see the work the directors had in managing the allotment. I believe there was some little feeling of irritation that we had not allotted satisfactorily. I can assure you the labour was intense. We had 2,677 applications, which is rather a large number in so small a company, and we have now 700 shareholders. And now, gentlemen, I must congratulate you an another fact which is, you have got your settlement and quotation. I believe many of the other companies who came out have only got one or neither, therefore I think it shows everything done was done with the approval of the Stock Exchange, and everything was fair and above board. I think that is a matter which must be very satisfactory to the shareholders. Now, we have no intention of issuing additional capital just at present. Of course, that will depend upon the work we get in Scotland. We are getting applications for tenders for our work daily, and I hope very shortly to be able to issue to you a very good report of what the work is. But you must remember we have been delayed very much in our action by the law proceedings in Scotland with regard to the liquidation of the old company. That is now perfectly completed—finished yesterday, and we, of course, could not undertake the election of officers, or the beginning work, or hardly making tenders of any sort or kind until we were perfectly sure we had everything in the liquidation we could possibly desire. That, I am happy to say, is now completed. We have appointed our chief electrician and manager with whom we had the highest testimonials in Scotland, and we have also appointed Mr. Brocklebank as our secretary and Mr. Wylie as our agent in Edinburgh, and we have another agent, Mr. Martin, in Dundee. I may say they are most energetic, most urgent, in pushing forward the business, and at present the board are perfectly satisfied with the working in Scotland. Scotland has the advantage over many other places from its knowledge of water power, and having water power. In al houses, large private houses and factories, that is of immense importance, because you reduce the cost of the electric light to a minimum, whereas, for steam power, you have to add the expense, which does not always contrast favourably with gas lighting. Therefore, I have always looked upon Scotland as being adapted for the electric light. There is hardly a farmstead does not utilise water in more ways than one, and it is perfectly feasible to adapt your water powers to your dynamos for the production of light, therefore I think Scotland is a very good field for the electric light. I shall be very happy to answer any question that may be asked me. It is not my intention to delay you long, because this is a statutory meeting, but if any questions are asked I shall be happy to answer them.

Mr. J. Walker: May I ask if you have done any work in Glasgow or Edinburgh?

The Chairman: We have lighted the Waverley Station in Edinburgh.

Mr. Walker: That is all.

The Chairman: Our liquidation was not completed. We are lighting, at the present moment, the Waverley Station, which is the great station in the interior of Edinburgh. It is the centre station. We have tenders out for the lighting of the Tay Bridge Station, and other tenders for the east station of Dundee. We have many mills sending up for tenders, and we

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hope shortly to do work for the mills; but the Scotch people are careful, and do not like to jump in the dark.

Mr. WALKER: Is it a profitable contract you have entered into?

The CHAIRMAN: We believe it to be so.

Mr. WALKER asked if there was any dispute between this and the old company.

The CHAIRMAN: Not between us. I was not going to enter into other people's business, but there was a dispute between them and the Anglo-American about the appointment of liquidator, and this caused their going to the law courts, which caused considerable delay to us. There was no hostile feeling between us—we are perfectly friends, all three; but there was a question about the liquidator.

Mr. WALKER: And does it entail any cost to this Company?

The CHAIRMAN: I believe nothing at all. They only sell to us as vendors. The similarity of name with the other company caused a great deal of confusion; people wanted to know whether we were winding up, and all sorts of things.

Mr. PRICE thought the answer they had received with regard to the working of this Company was not altogether satisfactory. The undertaking was started in May, and nothing had been done beyond the lighting up of a few stations. The liquidation of the old company ought not to interfere with the progress of this Company. He was sorry to say that they had given £55,000 for the patents and the system, and, if they considered the merits of the system, that was an excessive price. It was stated in the prospectus that the object of the Company was to light up public streets, public buildings, and private houses. As far as he understood, they were not in a position to light up private houses; they were not able to compete with gas in lighting up private houses, for the simple reason that they did not possess all that was necessary to compete with other systems, their system being, of course, incomplete. He referred more especially to a very important thing, that was secondary battery accumulators. He did not believe that that was included in the Brush system. He believed that without a secondary battery they could not compete with the lighting up of private houses. It was a matter of impossibility, and, to prove that, he referred to the speech of the chairman, the Earl of Crawford at another meeting. The statement in the prospectus that they were prepared to light up private houses was misleading, and he for one would not have subscribed his money if he had known the system was not complete, and this, he believed, was the cause of the shares being at a discount. He believed that the majority of directors of electric lighting companies were too fond of blaming the purchase clause in the new Act. He believed that that clause would be amended at some future time, but at present it was better to accept it as it stood rather than be without a bill, because in the latter case they would not be able to break up the streets. He would like to know if there were any calls in arreas, and if the directors had a substantial interest in this company beyond that required to qualify the directors.

Mr. DICKSON (the managing director): I will endeavour to answer a few questions put by the gentleman. As regards the work done from the time that our Company was inaugurated and the shares allotted, we had, of course, to face the difficulty which has been mentioned of the liquidation of the old firm, and, although it has been said that we should have gone and plunged into work rapidly, I think as prudent men we are quite justified in waiting until we saw how this dispute between the Anglo-American Brush and the Scottish Brush was going to be settled. We had nothing to do but to look to the shareholders' money, and we were determined to part with nothing until our lawyer satisfied us we were perfectly safe. To have gone to work and found a lot of lawyers hanging round our neck would not have been satisfactory to any one. As to never having heard of the old company, it was well known to all who invested we were taking over a concession of a company in Scotland who had been working before. They were the first parties who held the concession from the Brush Company, and it was stated we were taking over the concession in as direct English as possible from the Anglo-American, and, therefore, we really could see ourselves well through, and the shareholders properly protected. I am very sorry that Mr. Price said we had paid a very large sum—£55,000. We have not paid £55,000. If you look at all the Anglo-American concessions you will not find the Scotch stands worse off than the others. We paid £15,000 in cash, and for that we have the whole thing clear without the numerous expenses of floating companies, such as advertisements, brokerage, and all those kind of things which run away with a good many thousands of pounds, and the balance is in shares for which none of you have paid anything. As regards our coming into work we all know the height of the summer is not the time when people are rushing for light. It is in the dark nights that people come to think that they want something better than gas. Across the border they look quietly and cannily at it. When we floated this Company the Crystal Palace Show was going on, and people said naturally, "We will not go into these things until we see which is the best." Numerous times I was asked at the Crystal Palace to show the Brush system, and every one went away impressed that the Brush system was the best. We did not push the business until we saw our way clearly, but we took in hand the business that was inaugurated. Every one knows the Waverley Station in Edinburgh—one of the most important. To show you the North British are aware who they are dealing with, they had only 16 arc lamps last year, and they have given an order for doubling the number, and we are putting them up with a most efficient staff, and with proper instruments, so that the sort of slip-shod way in which this thing was done before will not occur again under the charge of your board of directors here.

Mr. WALKER: Is the contract for the lighting at Waverley Station for a series of years?

Mr. DICKSON: We have it for several years. Of course the railway companies say, "You light us this station, you carry it on for a certain number of years, and then we will buy it from you." I think we are all friends here. We have many opponents in Scotland, who are watching to see how contracts are made, and what is done. I think you may take it the directors are doing their best, and it would not be judicious to say what we are paid. It would be a benefit to other people and harm us. With our powerful engines there we can light up the whole of Princes-street without paying large rents for central stations. We have tenders also for Dundee and Arbroath. We have estimates also for the Tay Bridge. If we can get it there it will be an advertisement for our system, so that I think we see our way to a good business. If we cannot compete with gas we shall be in the same position as gas, but I think when once inside the house our profit will be as assured as all those far seeing people still think the electric light will be. As regards the accumulators, a gentleman said at the Storage Company he had heard the chairman say they had secured storage batteries, and, therefore, they were in a position to do a great deal more than what we have done—but they had to pay for it. I cannot see in the present financial stage it is prudent to rush in and buy those things at the highest price. We have kept our money, and we are ready to take advantage of the very best storage battery that we can possibly get. We have got the money to pay for it, and we have the wisdom, I hope, to make a good bargain. When we have the secondary batteries and arc lights, and are inside the house the way is clear to us. No one who reads the evidence before the Parliamentary Committee can have the least doubt about that. I may say we have been in treaty for a number of months past for the best battery in the market, which comprehends all the five best patents known as regards storage batteries. It is the same as the Oriental Storage Company has. I thought when we met here the chairman might have stated that we had made arrangements also which would give us not the worst bargain that has been made. I think we have done no harm whatever by delaying and holding our money. As regards our noble chairman, I am sorry he is not here to-day. He takes a most earnest interest in the Company's welfare. As an amateur electrician few can equal Lord Crawford, and so thoroughly had he an interest at heart that when he went to the House of Lords he went thoroughly determined to have these two objectional clauses altered, that is No. 2 and No. 7, and by his personal position in the House of Lords and the influence of his colleagues there, I think it was in a great measure due we have got seven years instead of five for our licenses, and 21 years instead of 15 for our provisional orders. I hope when Parliament meet next Session the two clauses which are now in opposition to each other will be amended. I think, taking the Bill as we have it, it is a very good Bill to go upon, and if we have not proceeded further it was due in a great measure to not having had this Bill passed. We could not go into houses or take up the pavement, and it was better to let our money lie in the bank than to attempt to do things we could not do. Now we can take up the streets, and we have an Act of Parliament that I believe will do us great good. Your directors have the interest of the shareholders at heart, and with the low price of coal, all those immense factories in Scotland, with the water power available in every gentleman's seat and every castle in the North and every mill, I think if we use our senses and do not expect too much we have as fair a prospect of doing good as most things that are brought before people.

Mr. LADD: Although I am not accustomed to public speaking I should like to say a few words, the tendency of which will be to give you confidence in the property in which you have invested. I am an old electrician, and one of the poineers of electric lighting, therefore I flatter myself I know something about the different machines and the different systems that are at the present day in vogue. The Brush machine, I believe, after considering all the other systems, is far, very far, in advance of any other for large lighting, I mean for extensive districts. There is no other machine that can send the electric current so far as the Brush machine; there is no other machine that can give you 40 lights in one circuit; there is no other machine that can at all compare with the Brush machine for economy. I say "economy," and I mean that. If you want one or two lights there are other machines, but if you want to light up streets, if you want to light up houses there is no other machine in existence that will take so many lights, and, although the price of the machine may appear to be somewhat high, the price of the machine is far below that of any other machine when you come to light up a town, but when you come to light a number of streets, 40 lights from one machine means what many of you may not know—two wires, or rather one wire, going through the whole of those 40 lights and back to the machine, whereas in other systems you require for large lights a machine for each lamp, and that means a very great expense, more than is apparent at first sight, because you want separate wires for each light and back again. With regard to those lights on the Embankment, I believe the Brush system would have lit up the whole of those lights, and given far larger light for what it has cost them to put down wires for those lights. That is a great step in advance of any other system, and that the Brush machine can do. I say, so far as we are concerned, Scotland is a splendid district for lighting, because of the water power that can be utilised; but there is one thing has told against Scotland, the Scotch people are scarcely educated yet up to the importance of electric lighting. We have to educate them, and what I am anxious to do is light up Glasgow or some large place like that, put out the present lights in the streets, and let the Scotchmen see what we have got, and I am quite sure that then they will have the good sense to see the advantage of it. Now, as regards the accumulators there was nothing said in the prospectus about the accumulators. That gentleman who spoke just now would almost imply he was imposed upon by the prospectus that was issued by this Company. Not so. A short time ago he purchased the few shares he has, and, therefore, he came into the Company long after the Company started, and ought to have made himself acquainted with all the ins and outs of the Company. If he did not understand it I do not think he ought to blame any one else than himself. It was unfortunate for the directors of this Company that there was such an enormous rush for shares; it gave them a great deal of power and a great deal of trouble, and a deal of work, and a great deal of dissatisfaction occurred amongst some people who said that the directors had appropriated a great number of shares to themselves. Well, now I can tell you this, that there was not a single director that appropriated more than 100 shares to himself. Although some applied for 500, they reduced the number because of the number that was applied for, and, therefore, I do not think there is anything to complain of on that score. I hope we shall go on prosperously. I believe we shall, and when we have the lighting of a few more stations in Scotland, I believe the thing will go, and, although we have not sole concessions, to tell you the truth I am very glad of it. I believe it will be far more profitable to work the system. It may be advisable to sell, but not during the reaction that has fallen upon electric lighting. This Company's shares have fallen. After a great cry for any particular thing there always is a reaction, and it has come to electric lighting, and the consequence is the shares have gone down, but you may depend that every share you have got is worth the money you have paid for it.

On the motion of Mr. WALKER a vote of thanks to the chairman and directors then terminated the proceedings.

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METROPOLITAN (BRUSH) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

At an extraordinary general meeting of the above Company. held on the 11th inst. at the Cannon-street Hotel, under the presidency of Sir Michael Kennedy, the resolutions passed at the extraordinary general meeting on the 24th ult., as reported in *The Electrician*, were unanimously confirmed on the motion of the chairman, seconded by Mr. James Whitehead, the chairman observing. as on the previous occasion, that they would enable the Company to obtain a quotation on the Stock Exchange. The statutory meeting was then held, and

The SECRETARY (Mr. A. Wilson) having read the notice convening it,

The CHAIRMAN said: Gentlemen—This is our statutory meeting, and as usual on these occasions we have not much to communicate to you. Up to the present time our business has been chiefly that of organisation and preparation for the work which is doubtless before us, and which we hope to carry on upon an extensive scale when winter brings us to long nights and frequent dark days. The Company was incorporated on the 15th of May, with a capital of £1,000,000, in 200,000 shares, of which 100,000 were at first offered. The shares applied for numbered 392,686, or nearly four times the number offered. All the available shares, namely, 100,000, were allotted, but this number was subsequently reduced by 310 withdrawals, which after careful consideration the directors felt constrained to admit upon legal grounds. We engaged suitable, but not extravagant offices at 110, Cannon-street. One of your first directors, Major Wood, resigned his seat at the board, finding that with the very onerous calls upon his time in other directions he would not be able to give that attention to our affairs which their importance demanded. The board was strengthened by the accession of Mr. Rose, of the firm of Morton, Rose, and Co., a gentleman, no doubt, known to all of you, by reputation at least. We entered into a working arrangement with the Hammond Company upon which we secured the services of Mr. Hammond as our managing director upon terms based upon a share of the profits. Mr. Hammond had previously gathered together a considerable staff and had explored, so to speak, the requirements of the metropolis as regarded the electric light, and had established lighting stations—one at Westminster, and another at Holborn. Mr. Hammond's reputation as an energetic man of business, and a successful organiser of the Brush system, must be very well known to all of you, and we feel that in making this temporary arrangement we did the best that was in our power to provide for the successful starting of our operations. We appointed Mr. Wilson, a gentleman who has had experience in public companies to be our secretary. As soon as our organisation had been completed, we proceeded to lay the foundation of that extensive business which we trust is before us. We advertised in all the chief newspapers, and we gave a wide circulation to a pamphlet, prepared by our managing director, which contains a full explanation of the Brush system, the prices of plant and machinery, and estimates of the cost of installations. Up to the present time our work has been confined mainly to small private installations. As regards public lighting, although we have been in communication with most of the public bodies throughout the metropolis, we have discovered objections to making any movement until the Electric Lighting Bill which has been before Parliament has become law. All who are interested in electric lighting must have followed the course of that Bill with a very considerable amount of anxiety and, perhaps, apprehension. I was prepared to address you in somewhat different terms to those I am now justified in adopting. I am happy to inform you of what I daresay you all know already—that on Tuesday last, when before the Committee of the House of Lords, the Bill underwent a very considerable modification. The terms for which licenses can be granted with the assent of local bodies was altered from five to seven years, and the period for which provisional orders can be granted was extended from 15 to 21 years. This, no doubt, is a considerable concession, but the objectionable clause of the Bill, the compulsory sale clause, still remains in its inequitable form, and it is to this point that we shall have to direct our future efforts with a view to obtain a very material modification of that clause. Under that clause, as I daresay you are well aware, electric companies are liable to be compelled to sell their property at the end of the period for which the provisional order has been granted for the mere price of the materials, without taking into consideration in any regard the goodwill of the concern. This, gentlemen, is very bad, but it might have been justified to some extent, at all events in theory, had there not been in the Bill a clause which regulates the prices at which electricity shall be supplied to consumers. The existence of that clause restrains electric companies from making large profits, while the sale clause compels them to sell their property at a time when, in all probability, they have just begun to reap the fruits of their enterprise. As regards our connection with the Bill, we have mentioned the steps that we shall take as soon as possible. It would not be advisable to make any detailed statement as to what these steps are. All that I can tell you is that we have arranged what shall be done, and shall lose no time in doing it. It is very encouraging to find that there is a general growing opinion that the electric light enterprise has before it a great and immediate future. Wherever the subject is discussed, whether in Parliament or out of Parliament, or in the columns of the public Press, that sentiment is almost universally expressed. After quoting from *The Times* of the 17th ult. an extract, in effect pointing to the progress which might be expected by those who undertook to supply the electric light and electricity, he continued: We have joined also in a very important movement. You are aware that there are many companies which derive their licenses as we do from the Anglo-American Brush Corporation. We have thought it desirable to form a council or conference of these companies, those boards concerned having agreed to send delegates to form the council. You will understand that, as our licenses are all precisely similar, and our territories all entirely distinct, we have no conflicting interests. We, therefore, thought that united action for a common object, and the protection of common interests, would have a very important effect in defending the general Brush interests. Already the council has met, has arranged its mode of procedure, and has passed important resolutions as regards the quality and cost of the plant and material which it receives from the Anglo-American Brush Corporation. These, gentlemen, are all the remarks I have to make to you on the present occasion. If any gentleman has any question to ask, I shall be very happy to answer it to the best of my ability.

A SHAREHOLDER referred to the expense that was going on, and inquired if any business was being done.

The CHAIRMAN repeated that they had been chiefly preparing to do the business when it arose, but they were at the present moment doing a considerable amount of business, and earning money.

Mr. PRICE referred to the advertisements which had been issued by the Streets Committee of the Camberwell Vestry, inviting tenders for lighting certain streets. He understood that only one tender was sent in. Was that from this Company? He also inquired whether the Company possessed the right to manufacture the carbons they used, or whether they were manufactured in New York and sent over here.

Mr. HAMMOND: The gentleman who has just sat down has asked four questions which I shall endeavour to answer. The gentleman who preceded him asked a question which has been already answered by the chairman, but perhaps the meeting will pardon me if I address myself to it also, as it really involves a great principle in connection with the business of the company, upon which all the members of the company ought to be perfectly satisfied immediately. An electric light company at its initial stage has a great deal of ground to cover in the way of preparing for business. I quite admit that if we are always to be only preparing for business we shall not do much good, but still there is much preparatory work that is inevitable and which is not of an immediately remunerative character. But while anxious to press that view forward we are also anxious not to be too closely questioned as to the exact mode of organisation which we have started in every part of the metropolitan area, because although we are, of course, here among friends and have all a common interest, and although I should like very much to make you all as enthusiastic as myself by telling you what is being done in a quiet manner, it would certainly be imprudent to do so. If I were to take you into the office and point to any street you might like to mention upon the map of London and show you the name of the traveller whose duty it is to canvass that street, you would form some notion how the whole of the metropolis, large as it is, is being grappled with. We do not want to tell our friends exactly what we are doing, but there is not a spot in the metropolitan area that is not receiving the attention of the Company. Although the preliminary work is expensive, yet if it is done in a systematic manner, and unnecessary outlay avoided, we feel confident that every sovereign we spend in organisation of the kind will come back in the form of three sovereigns. When any one, after repeated calls from our travellers, makes up his mind to have the electric light he naturally turns to the Metropolitan Company as one that he knows most about. Therefore, our time up to the present has by no means been lost. I would indicate another way we are proceeding, and that is the grouping together of districts, so that, instead of opening out a central station and asking for customers, we get the customers. I think, therefore, that we may ask for some forbearance on the part of the shareholders. You may rely upon it that we are not spending money in a manner that will do you no good, but that, on the contrary, everything is being done to secure the ultimate success of the company. Then there is the Electric Lighting Bill. There are certain matters connected with it that we do not quite like, and of which the chairman has expressed his disapproval. We were very glad to see that the Lords extended the limit from fifteen to twenty-one years, when the property of electric companies may be compulsorily purchased at the then market value. As a first attempt at legislation, I am perfectly satisfied with the Bill. I have a strong hope that next year it will be considerably improved in our favour, and, rather than take any action that might block the Bill, I am disposed to accept it. The efforts we were making at the last moment through the Press were so successful, that we got what we were striving for. There is a certain work connected with the Bill which will prove of immense value to this Company. I say no more. With regard to the other questions that were asked, it is true that tenders were advertised for by the Camberwell Vestry, and only one tender was sent in. Of course any one who knows the activity we are displaying would know that that must have been sent in by the Metropolitan Company, and so it was. That tender, if it had been accepted, would have formed the basis of the systematic lighting of Camberwell, which would have left a considerable profit to this Company. But let me just go a step further, because the gentleman said, "Let us have a plain answer to this question." I should not like to leave the impression upon any one in this room that I was trying to dodge the question. In the ordinary street lighting by gas you have at intervals down the street certain lights. Now, it is evident that if there was no light *en route*, the charge to the local authority of 2s. to 3s. per 1,000 feet would leave an immense loss. But when we have the mains down, and the whole thing is in full swing, we will at once put the price down. If a gas company were to ask, say, 21s. per 1,000 feet, which would not be a remunerative price for a limited number of consumers, people would at once say, "Oh, you are charging five times the price that my neighbour next door pays." We know what it will cost us to run a fair number of lights in a district. For example, our canvassers tell us that if we get one customer in a certain street there are others also willing to take the light. It is obvious that, if we are to give quotations for supplying lights at intervals of a few hundred yards, they must be very different from the price which would be remunerative when the whole concern is in working order: and of course the vestries would not look at estimates based upon the cost of public lighting alone. In regard to the Camberwell Vestry, we said we would only do the lighting on the understanding that we could supply the light *en route*. It is true they gave us leave to light *en route*; but only for a year. We, however, said that if we put down the mains they must stop there, for if the public lighting ceased we should still, in that case, be in a position to supply the light *en route*. With regard to this particular tender, I am anxious to show you that everything connected with it was carefully weighed and considered from the point of view of the interests of the Company. With regard to carbons, I am glad to tell you that we have every power to get our carbons in the cheaper market. We are not bound to any particular company for carbons. We are bound, as you know, to the Anglo-American Brush Corporation for its machine and lamp; but though, as a matter of fact, we find it convenient to go to the Brush Company on account of its complete organisation for many other of our materials, yet in carbons we are perfectly free. As a matter of fact, at the moment we are going to the Anglo-American Corporation for carbons, because we have an arrangement with them by which we buy the carbons from them upon what we consider cheaper terms than we could get them from anybody else. It is true that the Anglo-American Company get their

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carbons from America, but they get them under very special terms with the patentees, who have the sole right of making them in this particular manner, and they feel that they are doing the best thing in getting them from the makers. If, as I believe has occurred upon one occasion, an offer of a large number of carbons were made from another quarter, both the Anglo-American Company and ourselves would at once embrace it. The question of carbons is a serious one. It does not do in carbons to be chopping and changing. If we were to buy every job lot that turned up it would tell very much against us. It is necessary, in order to secure good carbons, that they should be carefully tested and sorted out here. One does not want to prophesy, as the chairman of the Brush Company said the other day, but we may have a good deal to say to you about carbons later on. Rest content with this, that we are keeping a very serious eye upon that point, especially as we find that the man who puts up the light generally gets the order for carbons and any trimmings that may be wanted. If we light up, for instance, this hotel in which we are now assembled, as it is quite on the cards we shall, it is very probable that they will send to us for their carbons, and while we are getting our profit on the installation, we are glad to think that there is always a little profit coming in annually in the form of attendance and carbons, which really amount to a very good sized item, and as installations multiply this will become an important source of income to the Company. Another question referred to the lighting of the railway stations in London. With one exception, the railway companies in London have, after trial of the plant, paid for it, so no question of yearly profit arises, except the profit which arises from the supply of carbons. The Great Eastern Railway Company tried the Brush light for some months, and on finding that it worked satisfactorily they gave a cheque, and so settled the business. The only station which is not in the same position is the Charing-cross. There the Anglo-American Company are running the light for the gas bill of former years to show what its system can do. But they run the light under such favourable circumstances that they feel themselves fully recouped by the gas bill, because, instead of having to put up a separate installation, they really run it from their shop in Lambeth. It is often asked how it was that they could run the light so cheaply; but you can easily understand it if you go over to Lambeth and see how a circuit of five miles is worked. Instead of having one machine to do the whole lighting there are thirteen machines, and instead of one wire there are eighteen wires. Thus you will see how it is that the Brush system can compete with other systems. In its method of manufacture and distribution the Brush is, at the moment, at the head of every other system, and will, we trust, remain so. With regard to Charing-cross, the position is that the Brush Company is able to use the same power which makes its tools during the day for running the light at night. It has no rent to pay, and no fresh machinery to put up; it merely turns off the power which has been working a lathe on to a dynamo machine.

Replying to a shareholder Mr. HAMMOND added that the lights at present being run by the Brush Company were those in the City, which were also running from their works. There were no others.

The CHAIRMAN, in answer to another question, stated that the Hammond Company obtained from the Anglo-American Brush Company a concession for the City of Westminster, and they also had other lights in various parts of the metropolis. These rights were extinguished by an arrangement with the Hammond Company. In answer to Dr. Rosenthal he added that with regard to a secondary battery their policy had been a waiting policy, to see which was the best. They had good reason for hoping that the results hitherto obtained from the accumulators best known would shortly be exceeded by some others. Offers had been made to them to acquire concessions of certain accumulators, but for the reasons stated they had been rather disposed to hold their hands. An accumulator was a necessity for large systems of electric lighting, and the matter was engaging the attention of the board.

Mr. JAMES WHITEHEAD (deputy chairman) said he would reply to the question which had just been put. Out of the total sum of £300,000 called up there only remained £3,000 unpaid. Referring to the price of electricity, as compared with gas, he did not know whether those who had considered the question had fully taken into account the very large extra amount of light given to the public by the electric system. Let them look at this point as illustrated by the tender sent in by the Metropolitan Brush for lighting the city. This company had, through their managing director, Mr. Hammond, offered to light the four districts put before them by the Corporation for £3,000, and if, in addition to that sum, the Corporation charged themselves with £725 a year (which would be ample) for wear and tear of the necessary machinery, the annual expenditure would amount to £3,725. The cost of lighting by gas at present was £1,867. This showed, no doubt, a considerable difference, but the light given by electricity was 16½ times greater than that of gas, and if he did not mistake the feeling of the public there was a determination to have a greatly improved light, although it might cost more. This desire was recognised by the recent introduction of new gas burners. These lamps possessed less than half the illuminating power of electricity; yet, if adopted, they would cost the Corporation £9,335 (exclusive of the allowance for the new burners and lamps), or, in round figures, three times the amount for electricity as supplied by the Metropolitan Brush. He thought that these facts could not be too widely known. With regard to the Electric Lighting Bill, which was about to receive the Royal assent, he considered that on one point it would deal most unfairly with this and other electric lighting companies. According to his reading of the Bill, they might be called upon at the end of twenty-one years to give up their property not as a going concern, but simply for the value of the materials existing at the time. This was an unjust position to place them in. Let them see how it would affect the property of their company. They had paid £235,000 for the exclusive use of the "Brush" and "Lane-Fox" patents over the metropolitan area. For the sake of argument let them assume that they spent the remainder of the first issue, namely, £265,000 in plant. These two sums made together £500,000. If at the expiration of the twenty-one years their Company was taken over by the local authorities at the then value of the plant the £500,000 would probably not be worth more than one-tenth the cost of the plant, viz., £26,500. In other words they would have to provide £473,000 or £31,566 per annum to liquidate the prospective loss. He based this on a calculation of fifteen years only, for it would hardly be fair to assume that they could count on more than fifteen profitable years, seeing that they had in the early stages to overcome many difficulties, especially those of prejudice and vested interests. This calculation, moreover, did not take into account the usual repairs and wear and tear of the machinery. He laid these serious figures before the shareholders, not because he wished to create any misgiving in their minds respecting the future of the Company to which they belonged, but because he wanted to show the necessity for every one connected with electric lighting enterprise to put his shoulder to the wheel in order to bring about such an alteration of the Bill now about to become law as would place them on a fair and equitable footing for competing with the gas companies who were already in the field. This was a question which concerned in an important degree not only the shareholders of this and other companies but the general public, who, he believed, fully recognised the superiority of electricity over gas. Very few would now be prepared to deny the existence of these advantages. Not only was it more brilliant but it showed colours in their true shades as in broad daylight. It was cooler than gas. It did not tarnish decorations or curtains, and above all it did not vitiate the atmosphere so as to be injurious to the health. The public recognised all this, and were anxious to have the light. It was, therefore, manifestly to the interest of the public to join with the directors and shareholders of this Company in bringing about such modifications in the Electric Bill as would enable them to secure the best illuminator at the lowest cost. He believed with these alterations in the Bill there was an excellent future for the Company.

The CHAIRMAN, in replying to a question, stated that the directors had a substantial interest in the concern. There was no intention whatever of making a further call, and, in fact, no call could be made till the progress of the business justified it.

Mr. HAMMOND, alluding to the remarks which had been made on the Electric Lighting Bill, reminded them that he had said he was fairly satisfied with it as a first instalment of legislation. A difference of opinion had prevailed in the House of Lords and the House of Commons as to the exact application of the clause relating to compulsory sale. There was one thing quite certain, however—that in the purchase price nothing was to be given for goodwill or any profits which may or might have been made from the undertaking.

After a few observations from Dr. Pocock on the advantages of the electric light generally, the meeting closed in the usual manner.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Aug. 16.		Business Done Week Ending Aug. 16. Highest.	Lowest
Anglo-American	49,	50	50	49¾
Do. Preferred	79½,	80½	80½	80¼
Do. Deferred	19½,	20½	20½	20
Brazil Submarine	11½,	11¾	11 11-16	11⅝
Cuba	9¼,	9¾	9 9-16	9 9-16
Do. Preference	16,	17	16½	16½
Direct Spanish	5¾,	6¼	—	—
Do. Preference	15½,	16½	—	—
Direct United States Cable	11½,	12	11¾	11¾
Eastern Telegraph	10½,	10¾	10 9-16	10 1-16
Do. 6 per Cent. Preference	12¾,	13	12 15-16	12¾
Do. 5 per Cent. Debentures, 1899	100,	105	—	—
Eastern Extension	11,	11¼	11½	11 1-16
German Union	9¾,	10¼	10½	10
Globe Telegraph and Trust Company.	6¼,	6½	6 7-16	6½
Do. Preference	12½,	12¾	12 9-16	12½
Great Northern	12½,	12¾	—	—
Indo-European	28½,	29½	29½	29½
Mediterranean Extension	2,	2½	—	—
Do. Preference	8½,	9	9	8½
Reuter's	12¾,	13¼	13¾	13
Submarine	255,	265	—	—
West India and Panama	1½,	1¾	1⅝	1 9-16
Do. 1st Preference	8½,	8¾	8¾	8¾
Western Brazilian	6¾,	7¼	7	7
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	103,	106	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1¼,	1¾	1 5-16	1¼
Oriental	⅜,	⅝	½	7-16
United Telephone	9½,	10	11 7-16	10½

ELECTRIC LIGHT.

Electric Light and Power	⅜,	⅝	½	⅜
Anglo-American Brush	10½,	11½	16½	14½
Eastern Electric	2,	2½	3	2

TRAFFIC RECEIPTS FOR JULY, 1882.

Companies.	June, 1882.	June, 1881.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,800	2,397	403	—
Direct Spanish Telegraph Company	1,846	1,448	398	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	30,070	31,751	—	1,681
Eastern Telegraph Company	51,600	38,171	13,429	—
Great Northern Telegraph Company	21,640	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

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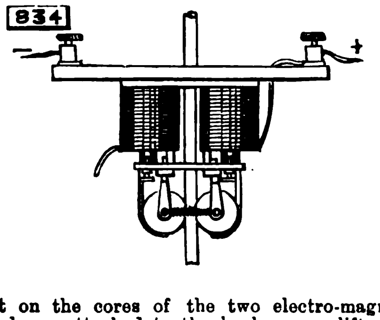
RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

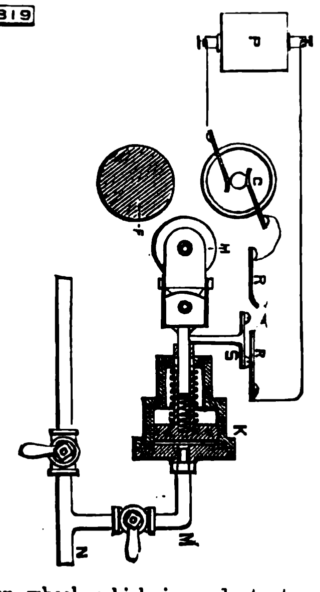
834. Improvements in Electric Lamps or Lighting Apparatus, *W. R. Lake, London.* —*21st February*, 1882.—*(A communication from B. Lande, New York.)* 6*d*.

This invention relates to a mode of regulating the upper carbon by the two pulleys shown. When the arc is to be established the brake arms shown clamp the pulleys. The action of the current on the cores of the two electro-magnets which are attached to the brake arms lifts the upper carbon and establishes the arc. As the carbons are consumed, the current through the electro-magnets weakens, the brake arms and cores fall and release the pulleys, through which the carbons descend until the arc is the proper length.



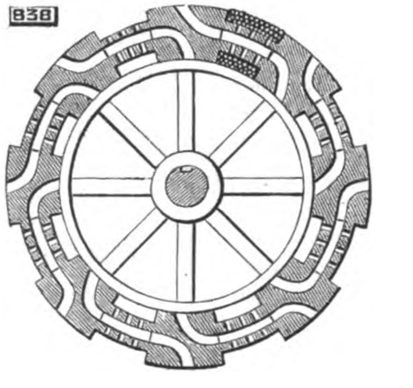
18. Improvements in Electric Lighting Apparatus for Railway Trains and other Moving Vehicles or Vessels, *S. Pitt, Sutton, Surrey.*—*20th February*, 1882. —*(A communication from E. T. Starr, Philadelphia.)* 8*d*.

This relates to improvements on patent dated 21st December, 1881, for driving a dynamo machine from the axle of one of the vehicles of a train, and in connection with a storage battery supplying currents for lamps at the front and rear of said train. The figure gives a diagrammatic view of the various connections. F is the axle of the tender carrying the dynamo. H is a friction wheel, which is made to transfer the motion of F to friction wheel G, which is attached to the shaft of the dynamo when the piston K is thrust forward by the steam which acts on the steam brakes attached to the train. N is the main steam pipe for such purpose, and M the branch pipe leading to the piston. Thus, when the brakes are applied, the piston will be thrust forward, making connections between the axle and the two friction wheels, and also between R, S, and R¹, so as to complete the circuit with the secondary battery P, which will be charged. In the figure the circuit is shown to be broken, so as to prevent the current from the battery from returning through the dynamo. The current from the battery is led to lights at the head and rear of the train, the current to the latter being broken by a circuit breaker connected with an axle of a carriage, so that the light will give out flashes, the rapidity of which will be an index of the speed of the train to drivers or others behind it.



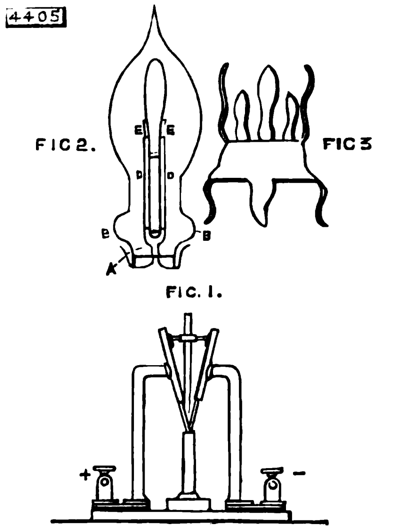
838. Improvements in Dynamo-electric Machines, *W. R. Lake, London.* — *21st February*, 1881.—*(A communication from B. Lande, New York.)* 6*d*.

This consists in improvements in the Pacinotti machine by the introduction of air passages into the pole pieces and the armature, so that constant currents of air pass through the interior of the ring as it revolves. The inventor describes several methods of carrying out his improvements, one of which we illustrate. The figure is a transverse section of the armature showing the arrangement of the air passages.



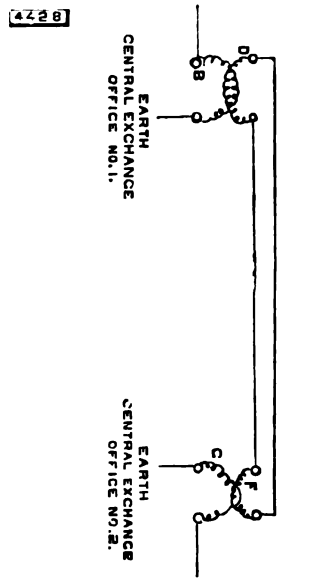
4405. Improvements in and Apparatus for Producing the Electric Light and in the Manufacture of Carbons Therefor, *A. M. Clark, London.*—*10th October*, 1881.— —*(A communication from Madame J. de Changy, née de Deyn, Paris).* 10*d*.

One part of this invention refers to several modes of rendering the carbon incandescent without its being traversed lengthwise by the current. Fig. 1. shows one method of carrying out the invention. The carbon is introduced between two inclined metallic or carbon electrodes resting upon an insulated block, or one of insulating refractory material. The two electrodes alone are in circuit, and the point of carbon closes it. Another part of the invention relates to a method of preparing carbons by causing porous substances, such as linen thread, to absorb carbon from a bath of some boiling hydrocarbon, and afterwards subjecting them to calcination. Other methods are also described. Fig. 2 shows an incandescent lamp, also the subject of this patent. The tubular neck A is formed with a swelling at B, for engaging with the metallic clips shown in Fig. 3, which serve to form contact. The carbon holder is formed of a steel tube, upon which is spun a tube of glass enamel, D. At the upper part a platinum wire is soldered with silver or platinum, said wire being itself connected by glass tube, E, united to enamel sheath, D, while the latter and the platinum are united to the sealed end of the neck.



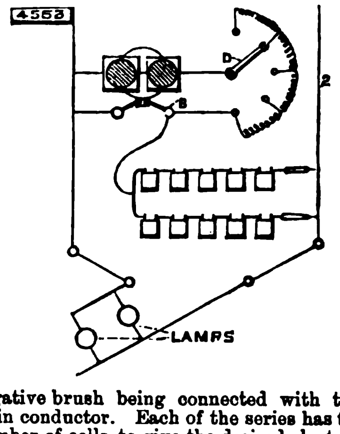
4428. Improvements in Telephonic Apparatus, *A. R. Bennett, London.* — *11th October*, 1881. 6*d*.

This relates to a means for enabling subscribers who are in communication with central exchange offices by single wires, the exchanges being connected by double wire, to converse; also for modifying the inductive effects on a single wire. The mode of carrying out the invention will be seen from the figure. B D and F G are layers of an induction coil, which transmit the currents from the single to the double lines by induction, a method by which each coil may be made to transmit signals between the central offices by the addition of a system of permanent magnets, the alternate poles of which are revolved by a crank, as closely as possible without contact, to one end of the iron core of the coil, the other end of the core being fitted with an iron disc, in connection with battery and bell, &c., also described.



4553. Improvements in Method and Means for Charging and Using Secondary Batteries, *P. Jensen, London.*—*18th October*, 1881.—*(A communication from T. A. Edison, Menlo Park, U.S.).* 6*d*.

The object of this invention is to provide a method by which the electromotive force of a current supplied by secondary batteries may be maintained at a practically constant pressure. The inventor describes three methods of doing this, one of which is shown in the figure. The cells are coupled up in series, and connected to positive main conductor 2 by switches. The other ends of the two series are connected to positive commutator brush B of a dynamo, the negative brush being connected with the other main conductor. Each of the series has the right number of cells to give the desired electromotive force. Both series may be connected to the main conductor at once by the switches, or one may be used to reinforce the other. When the current from the cells begins to drop in pressure, switch D is moved to the outer set of resistances, and the engine that drives the dynamo is started. This throws a reinforcing current in multiple arc through the cells. At each subsequent drop in the electromotive force, the switch D is moved inwardly to the next contact of the set of resistances, and the standard electromotive force maintained.



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SLIP

ELECTRIC LIGHTS IN SPRINGFIELD, MASS.—An American contemporary says there are sixty electric lamps in use in Springfield.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY. — The traffic receipts of this company for the week ended August 18 amounted to £2,519.

THE EDISON TELEPHONE PATENT.—The disclaimer of the phonograph from the Edison telephone patent has been allowed by the Attorney-General.

THE CHARING CROSS ELECTRIC RAILWAY.—The Charing Cross and Waterloo Electric Railway Bill has been read a third time in the House of Lords, and passed.

ELECTRIC LIGHTING AT SWANSEA.—The Swansea Harbour Trustees have completed arrangements for lighting the entrance to the Swansea Dock with Brush arc lights.

DESTRUCTION OF TELEGRAPH LINES IN SPAIN.—According to recent telegrams to the daily press a band of Carlists has been destroying large numbers of telegraph posts in the Republic of Andorra.

THE COALBROOKDALE COMPANY.—This well-known Shropshire firm have opened show rooms at Nos. 43 and 44, Holborn-viaduct, E.C., which are to be lighted throughout by the Edison system.

THE TELEPHONE IN THE BARBADOES.—"The telephone service is being rapidly extended in Bridgetown, most of the mercantile offices being now in connection with the Exchange," says the *Colonies and India*.

TELEGRAPHS IN GERMANY.—It is said that Germany has 5,900 telegraph offices, about 37,300 miles of ærial line, with about 117,000 miles of wire, and about 1,560 miles of subterranean line, with 10,000 miles of wire.

ELECTRICAL EXHIBITION AT MUNICH.—We would remind any of our readers who may be holiday making on the Continent during the ensuing month that the Munich Electrical Exhibition opens on the 16th September.

ELECTRIC LIGHT AT SOUTHAMPTON.—We understand that during the meeting of the British Association at Southampton, which commenced on Wednesday last, the Hartley Institution is to be lighted by the Edison system.

THE JABLOCHKOFF LIGHT ON THE EMBANKMENT.—We learn that permission has been given to the Jablochkoff Electric Light and Power Company (Limited) to erect a new building in place of the present shed on the Victoria Embankment.

THE DYNAMO-ELECTRIC MACHINE.—At the recent meeting of the Institution of Mechanical Engineers held in Leeds an interesting lecture on "The Dynamo-electric Machine" was delivered by Professor Rücker. This lecture we shall hope to reproduce in an early number.

THE EDISON INCANDESCENT LAMP PATENTS.—It is stated that the British Electric Light Company have recognised the fact of their infringement of the Edison patents for electric lighting by paying a substantial sum as royalty to the Edison Electric Light Company (Limited).

THE MAXIM LAMP.—The Maxim-Weston Electric Company give notice that they have reduced the price of their Maxim incandescent lamp as follows:—For any number less than 100, 7s. 6d. each; for 100 and upwards, 6s. each. It will be remembered that this lamp gives a light of 50 candle-power.

THE TELEPHONE IN BRIGHTON.—The United Telephone Company have opened an exchange at Brighton, and active operations have commenced. Arrangements for connecting that town with the metropolis by a telephone line under the powers which the company hold from the Post Office are now being made.

THE CRYSTAL PALACE EXHIBITION.—According to the *Journal of Gas Lighting* the amount already subscribed by various gas companies to help to defray the expenses of the gas interests at the forthcoming Exhibition of Gas and Electric Lighting, to be held at the Crystal Palace, amounts to £1,851 6s.

ELECTRIC LIGHT IN THE "SERVIA."—The *American Gas Light Journal* is responsible for the statement that the average number of Swan lamps which get broken or out of order during each voyage of the Servia between Liverpool and New York, or *vice versâ*, is 15 to 16, the total number in use being 140. The same journal characterises the light given by the lamps as "beautiful, steady, and agreeable, and certainly better than oil lamps."

PERSONAL.—Many of our readers may be interested in knowing that Lieut.-Colonel C. E. Webber, R.E., President of the Society of Telegraph Engineers and of Electricians, has been suddenly called out for active service in Egypt, having been appointed A.Q.M.-General on Sir Garnet Wolseley's staff. Colonel Webber left England for Egypt, *viâ* Brindisi, on the 18th inst. It will be recollected that he served on Sir Garnet's staff in South Africa in 1879.

TELEGRAPH STORES WANTED.—The Caledonian Railway Company are inviting tenders for the supply of india rubber, iron wire and strand (galvanised), telegraph instruments, &c. Specifications and forms of tender can be had from Mr. William Haig, superintendent of stores, Caledonian Railway, St. Rollox, Glasgow, where patterns may be inspected between 9 a.m. and 5 p.m. Tenders, endorsed "Tender for Stores," are to be lodged with the Secretary, 302, Buchanan-street, Glasgow, by the 4th September.

A NEW TELEPHONE RECEIVER.—It is rumoured that a new telephone has been patented and put upon the market on most advantageous terms, a company having been formed for working the instrument in opposition to the Bell system, the principle of which this patent is said not to infringe. We understand that the new receiver consists of a primary and secondary wire wound round a metallic bar, at each end of which is a fixed disc. One of the joint patentees is Mr. H. R. Kempe, of the telegraph department, G.P.O.

ELECTRIC LIGHT ON SHIPBOARD.—The "Invicta," a new steamer recently built for the London, Chatham, and Dover Railway Company, and which made her first passage from Dover to Calais on Saturday week, is lighted by means of Swan's incandescent lamps in the saloons, engine room, and other parts between decks. A large electric lamp is also placed on each paddle-box, these latter being intended to be used for embarking and disembarking purposes only. The dynamos which supply the current are driven by a Brotherhood three-cylinder engine.

EDISON'S SYSTEM AT CAPE TOWN.—Edison's Foreign Electric Light Company have received a letter from Mr. Grier, chief inspector of the Department of Public Works at Cape Town, expressing, on behalf of the Government, their satisfaction at the manner in which the company have carried out their system of electric lighting in the House of Assembly. Mr. Grier also bears testimony to the efforts of Mr. Hortsek, the company's electrician, whom he speaks of as having "spared no pains to carry out your instructions, which have been so completely successful."

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ELECTRIC LIGHTING IN MANCHESTER.—Some time since the directors of the Manchester Royal Exchange resolved to introduce the electric light into the building, and entrusted the work to the British Electric Light Company. On Monday last the lights were turned on for the first time. The results, according to the *Manchester Courier*, were most satisfactory, the two arc lights in the portico facing Cross-street completely eclipsing, according to that journal, "what had been up to then considered the brilliant light of the recently-introduced patent gas lamps in the adjoining part of Market-street."

DYEING BY ELECTROLYSIS.—At a recent meeting of the French Academy of Sciences, M. Goppelsroeder read a paper on the use of electrolysis for dyeing and printing. M. Goppelsroeder impregnates tissues or paper with an aqueous solution of chlorhydrate of aniline, and puts it on a non-attackable metal plate, which he connects with one pole of a battery or other source. On the tissue or paper is placed a second metal plate having a design in relief and connected to the other pole of the battery; on pressure, and when a current is passing, the design is reproduced. A modification of this method gives chemical discharge of colour.

"THE TELEPHONE IN PRINCIPLE AND PRACTICE."—This is the title of a little pamphlet published by David Bogue, which treats of the history and development of the apparatus. We might take exception to several of "J. E. K.'s" statements, but will content ourselves with asking the exact part played by Sturgeon in the discovery of the electro-magnet. This great English physicist seems somehow to be forgotten or ignored. Why? The pamphlet, after a short introduction, describes the discovery of the telephone and its introduction as a means of communication. It contains a good deal of information, and may be read with interest.

ELECTRIC LIGHTING IN FULHAM.—The Fulham District Board of Works have entered into an agreement with the West Middlesex Electric Lighting Company, empowering the company to lay wires enclosed in pipes under the footways throughout the parishes of Fulham and Hammersmith, the distance of roads in the district being 37 miles, and the number of houses 29,000. It is proposed to erect at suitable points central stations upon a large scale within the two parishes for the purpose of generating electricity. Gramme dynamo machines will be used for this purpose. For street lighting Brockie's arc lamps will at present be fixed, and for shops and private houses the improved British incandescent lamp.

THE EGYPTIAN EXPEDITION.—Part of the plan of naval operations which commenced last Sunday appears to have been to cut the cable uniting Egypt with Syria, and so to stop communication between Constantinople and the rebel army. This step has provoked much comment, but, on the whole, it is recognised as a military necessity. At Ismailia, on the other hand, the telegraph was left intact for purposes of deception. The party which first took possession of the place being very small in numbers instantly seized the telegraph office, and despatched bogus messages announcing that some five thousand British troops had landed, the object being to prevent any attempt at recapture before reinforcements arrived. The ruse was completely successful.

ELECTRIC LIGHT IN SPAIN.—We are informed that the Anglo-Spanish Brush Electric Light Company have just completed two installations in Spain. The first at San Sebastian includes sixteen arc lamps, which are placed in the promenades and streets. In the promenades the lamps have a very pretty effect, and in the streets they are seen at their best, as the roads are very wide and run at right angles to each other. The other installation is at Irun, where the town is to be completely lighted throughout. Here the company have erected six arc lamps (Brush) and 75 Lane-Fox incandescent lamps of twenty candle-power. Both installations are, we hear, giving every satisfaction. The whole work has been carried out under the able superintendence of Mr. James A. Selby, the electrician to the Anglo-Spanish Brush Electric Light Company.

ELECTRIC LIGHT IN HULL.—At a meeting of the Hull Lighting Committee held last week, the town clerk read applications from several electric light companies for permission to light the town with electricity, to which he had replied to the effect that the corporation had already entered into a contract with Messrs. Siemens to light a portion of the town for twelve months, and that if the experiment was successful, the light was to be applied to the whole of the town. The chairman, in reply to questions as to the progress of the light in Hull, said he was not in a position to state when the light would be set going. The contractors were anxious to have everything perfect before handing it over to the corporation, and there was every reason to believe that the light would be a complete success. The corporation did not pay for anything till it was handed over. It would be a few weeks before all was ready.

THE ELECTRIC LIGHT FOR LICHFIELD.—At a meeting of the Town Council of Lichfield held a few days ago the tenders sent in for lighting the city were opened. The first was from the Lichfield Gas-light Company, and was to light the 212 lamps in summer and 220 in winter for the sum of £510 per annum. This included a reduction of 4d. per 1,000 in the price of gas compared with last year. The next tender was that of the Birmingham and Warwickshire ("Brush") Company, who offered to put up and maintain 25 arc lamps, of 2,000 candle-power each, at a charge of £25 a year per lamp. It was stipulated that the contract should be for five years, and that if the tender then lapsed a sum of £150 should be paid by the council towards preliminary expenses. It was further asked that certain concessions for a long period of years should be granted in regard to domestic lighting. After some discussion, it was decided to consider the gas company's tender only, and this was subsequently accepted.

ELECTRIC LIGHT AT LEEDS.—The summer meeting of the Institution of Mechanical Engineers has just been concluded in Leeds, where it was held this year. As a natural consequence of such a meeting, the busy manufacturing town was *en fête*, most of its works being thrown open for the inspection of members. On Wednesday week a conversazione was held in the Philosophical Hall, which was largely attended. Several of the rooms, as well as the entrance porch, were lighted by eight Brush lamps, whilst the room known as the Industrial Museum was lighted by 18 Lane-Fox incandescent lamps of 20 candle-power each. The current was supplied by a 16-light Brush dynamo machine, driven by one of Marshall and Co.'s 8 h.-p. patent Yorkshire engines with compound cylinders. The plant was lent by Messrs. Fowler, and put up by the Yorkshire Brush Electric Light Company. Amongst other historical and scientific curiosities to be seen was an observatory hive, with bees working under the influence of the electric light.

EDISON'S SYSTEM AT THE POST OFFICE.—Some time since we alluded to the probability of a portion of the General Post Office being lighted by Edison's system. This is now an accomplished fact. The lights have been fitted up

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in the "Press Room," a very busy branch of the telegraph department, employing, as it does, no less than 1,200 persons. It occupies the whole of the upper floor of the western building in St. Martin's-le-Grand. There are 59 Edison incandescent lamps distributed over the room, the current for these being supplied from the central station at 57, Holborn-viaduct, by means of a main running up Newgate-street. The distance from the Edison Company's central station on the Viaduct to the Press Room at the Post Office is no less than 1,950ft. The system was introduced by the authorities on the advice of Mr. W. H. Preece, chief electrician to the Post Office, and we have every reason to believe that the *employés* in the Press Room will be extremely grateful for the change. It may be added that the work of preparing the Press Room for the reception of the new system of lighting was carried out in about ten days. The lamps were lighted for the first time on Monday evening, the 21st instant.

The President of the Western Union.—During these sultry summer days (says our American contemporary, the *Operator*) almost all prominent persons who can spare the time hie to Newport, Saratoga, Long Branch, the mountains, the lakes, or Europe, but Dr. Norvin Green, the president of the Western Union Telegraph Company, may be seen about the Western Union building every day. In all the many changes which have taken place in telegraph circles, in the transition from the Vanderbilt to the Gould *régime*, he has not been affected except to mount higher by each change, all of which is undoubtedly due to his superior insight and ability. The office of president of the Western Union Telegraph Company is, perhaps, the highest office in civil life in the United States, and ranks in emoluments and range of authority alongside of such offices as the presidency of the United States; and when the extent of the territory covered by this monster corporation is considered, reaching not only over the whole territory of the United States but also into the British possessions, Mexico, and other countries, and the fact that the tenure of office is unlimited while that of the President of the United States is but for four years, it would even seem in some respects to outrank the latter high office.

The Accident at the Tuileries.—Our contemporary, *La Nature*, speaking of the accident which occurred on the 6th August, during a *fête* in the garden of the Tuileries, at Paris, when two men were killed through touching some electric light wires, says that the accident must be set down to the imprudence of the victims. It appears that, in order to get a peep at the *fête* without paying, they tried to get over a fence, along which the naked conducting wires had been placed, although the public had been strictly forbidden to go near this fence. The current traversing the wires was of high tension, and, calculated according to the number of lamps in series, our contemporary estimates it at about 500 volts. The first man who received the shock died on the spot, the second lived for about an hour and a half afterwards. The *post mortem* was to be made by Dr. Brouardel, and would be interesting as being the first that had been made on any one killed by the current from dynamo machines. Our contemporary thinks that accidents will multiply, as the applications of electricity, and that the greatest precautions should be taken to insulate conductors, and in certain cases to keep them out of reach of foolish and evil-minded persons; that a learned society, such as the Academy of Science, Physical Society, or Society of Arts in Paris, should take up the question, study it with care, and lay down certain rules to be followed according to the nature of the currents employed.

The British Association.—The annual meeting of this association was opened at Southampton on Wednesday last by an address from the newly-elected president, Dr. C. W. Siemens. The address will be found in another column. Before reading his address, Dr. Siemens was introduced to the meeting by the past president, Sir J. Lubbock, in the following terms:—"To Dr. Siemens, in conjunction with his brother, we owe various fruitful improvements in the practical application of electricity, in anastatic printing, the chronometric governor, the regenerator engine and furnace, the electric railway, the electrical transmission of power, and other applications of science too numerous to mention. With all this scientific work he combines the management of immense business transactions. Perhaps the ruling idea of his life has been to economise energy, and to utilise the force of nature. The water-power, which runs to waste in our brooks and rivers, would save much expenditure of human labour. We may look forward to the time when the winds and the tide will to a great extent replace the furnace and the steam engine, so that Britannia will rule the waves in a newer and more peaceful sense. Dr. Siemens again, if any one, will stop the waste and worse than waste of coal which now hangs in a black pall of smoke over our great cities, and restore to them pure air, blue skies, and bright sunshine. We shall, perhaps, indeed—who knows?—one day burn our coal at the pit's mouth and convey the heat and energy by wires, or in some other way, to our fire places and manufactories, and though our coal, however economically used, must one day be exhausted, by that time, perhaps, we shall be able to store up summer heat for winter use or even to summon the subterranean fires from the centre of the earth, as I suggested with so much persistence, by earthquakes and volcanoes."

The Electric Light at Edinburgh.—After a trial of the Brush electric light lasting over a year, says the *Scotsman*, the North British Railway have resolved on an important extension of the system, under which the accesses to the Waverley Station and all the platforms will henceforth be lighted by electricity. At present there are sixteen lamps; under the new contract which has been made with the Scottish Brush Electric Light and Power Company, of which Messrs. Hope, Leith, are the agents, the lamps will be increased to thirty-two—the additional sixteen being intended for distribution on the out platforms upon the east and west sides of the station. On the east side the posts for the lamps have been erected each twenty-three feet in height, but as the departure platforms for Glasgow and the north on the west side are shortly to be covered in, three of the lamps intended for this part of the station will not be fixed until this long-delayed operation is completed. One lamp has been erected over the Princes'-street passenger entrance, and another half-way down the incline from the Waverley Bridge. For the service of the lamps a 40-light Brush dynamo-machine will be employed—the first of the kind in Scotland—and for its reception a new wooden building with slated roof has been put up to the east of the goods shed. The driving power will be supplied by one of Fowler's 20 horse-power patent semi-portable engines, with a fly-wheel 7 feet in diameter, and a stroke of 16 inches. The work is being carried out under the direction of Mr. James Partridge, the electrician of the Brush Company, and is now nearly completed. We are informed that the cost to the North British Company for lighting the station with electricity will not exceed what they formerly paid for gas, which, it may be stated, they manufactured for themselves. We understand that the Portobello Station and goods load-

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ing depot are also to be lighted with electricity on a different system, but at gas rates.

International Congress of Electricians.—On the 15th of October will commence at Paris, under the auspices of the Government, an international congress of electricians, says our contemporary, *La Révue Industrielle*. Before separating, Parliament voted a credit of 90,000f. to cover the expenses of this congress, so far as the French members were concerned. A convention will settle the manner in which the expenses appertaining to the labours which shall be prescribed by the international congress are to be divided between the various States. It is in response to a wish expressed by the congress of electricians which met in Paris last year that the French Government have called together the present meeting. The work before the coming congress will be:—1. To conduct experiments with the object of determining the electrical unit. 2. To effect precision in the methods of observing atmospheric electricity, in order to generalise such observations over the whole globe. 3. To collect statistics as to the utility of lightning conductors, and relating to the part played by telegraph and telephone lines, whether preservative or the contrary. 4. To organise a systematic study of earth currents on telegraph lines. 5. To consider the best conditions of the erection of a telegraph line, with special reference to the ascertaining of meteorological influences. 6. To determine a definite standard of light. The states who were represented at the electrical congress last year have just nominated their delegates to the present series of meetings. Another congress, which has also been summoned by the French Government, will meet in Paris at the same date. The duty of the members of this latter congress will be to consider the various questions relating to the safety of submarine cables. The apparatus which will be used in the experiments conducted by the first of these congresses are to remain the property of France. The expenses will be partly covered by moneys derived from the Electrical Exhibition of last year.

Burglars Scared by Electricity.—The following appeared in the *Glasgow Herald* of recent date:—Mr. W. H. Akester, electrician to the Universal Electrical Company, Glasgow, has been much annoyed for some months past by moonlight burglars attempting to break into his residence at Balvaird, Rutherglen, near Glasgow, and although he had complained repeatedly to the police authorities of the ancient burgh they seemed helpless to detect the offenders. He has, therefore, been under the necessity of devising a plan of adapting electric bells so as to warn him of the approach of burglars, and it has proved at once effective and inexpensive. Mr. Akester has had fitted up in his kitchen an electric bell, which communicates with the garden gate, so as to ring whenever the gate is slightly opened. At night the current is switched off the kitchen bell, and operates on a bell fixed in Mr. Akester's bed room. This bell not only communicates with the garden gate but with the doors and all the windows of the house. It has attached to it an indicator, which, immediately the bell is rung shows whether the thief is at the garden gate, at the hall door, or that of the kitchen, or at any one of the windows of the house, and the exact position of each of these, that is, how far open, when the bell rings. Some few nights ago, at a late hour, after the family had gone to bed, a couple of burglars opened the gate, which immediately caused the bell in Mr. Akester's bed room to ring. From the indicator he knew that they were just entering by the gate. Mr. Akester immediately got out of bed and dressed in haste, by which time the bell rang again, the indicator showing that the thieves were at the front bed room window, on the ground floor. Thinking that the servant had not retired for the night, and knowing that the bell is sometimes inadvertently rung when closing the shutters of the window, he called over the stair to see whether such was the case. No response was made, and he proceeded to the point indicated. The burglars, who by this time had obtained access to the bed room by the window, must have heard his voice, for, without taking any booty, they immediately took to their heels, and decamped. Mr. Akester has had no further annoyance from them since.

Fire Risks with Electric Lamps.—In obviating the fire risks incident to the use of oil and gas lights, says the *Scientific American*, electric illumination has quite fulfilled the promises first made for it, but users of electric lights are learning that they are not without their own peculiar hazards, which experience is the only means of discovering, hence the need of especial watchfulness for new developments in every part of the electric circuit. It will be remembered that the burning of a factory in Philadelphia some months ago was attributed to sparks of molten copper from the coating of the carbons of an imperfectly shielded arc lamp. More recently, in the same city, a large show window in a popular dry goods store was fired by a Jablochkoff candle. A careless attendant had neglected to screw on the brass cup below the light, and as soon as the current was turned on the fabrics in the window were ablaze from a shower of white-hot particles thrown off by the lamp. This was obviously no fault of the lamp, but the incident goes to emphasise the need of great care in its manipulation. Even the purely incandescent electric lamp is not without its dangers, as was discovered in a Philadelphia drug house a few days ago. One of the strong claims of this method of lighting has been its alleged inability to set anything afire. The nature of the "low tension" current supplying incandescent lamps was thought to forbid the system ever playing the part of an incendiary, while the security of the lamps was publicly demonstrated by breaking the glowing lamp in the midst of highly inflammable stuffs. Yet, in the case just referred to, a defective lamp came very near starting a serious fire. The lamp was in use in a cellar, and except for the fortunate entrance of an *employé*, the fire might never have been explained. He found the wires of the lamp—a Maxim lamp —white hot, with their paraffin coating blazing up against the beam and floor above. A well-directed hatchet stroke severed the wires, and the fire was stopped. An examination showed, according to the statement of Mr. M'Devitt, superintendent of the insurance patrol, that of the two wires, the one that enters the side of the brass shell below the glass globe in one of the lamps, and which is supposed to be firmly held in place there by a drop of solder, was not in fact so held, but seemed to have been loosely tied to the shell with a bit of copper wire, and to have dropped down from that imperfect fastening, crossing the other wires and establishing electrical connection with it. Both wires were, of course, white hot instantly. They were covered with a heavy insulating coating, mainly composed of paraffin, and that substance burned at once. But for the timely discovery of the accident, the entire establishment might have been destroyed. Upon a careful inspection being made of the other lamps on the premises, one or more was found in which the wire was simply tied on, and two others from which the drop of solder had been melted away, or else had never been there, so that the wire was loose and liable to fall at any moment. Thus we see in one city, and within a few months, each of the types of electric lamps has been the cause of a fire. However safe, as compared with kerosene, the electric lamp will bear watching.

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EXAMINATION QUESTIONS.

Questions set at the recent examinations of the City and Guilds of London Institute for the Advancement of Technical Education.

22 A.—TELEGRAPHY.

Instructions.

The candidate must confine himself to one grade only, the Ordinary or Honours, and must state at the top of his paper of answers which grade he has selected. He must *not* answer questions in more than one grade.

If he has already passed in this subject, either in the first division of the Elementary or in the Advanced Grade, he must select his questions from those of the Honours Grade.

The number of the question must be placed before the answer in the worked paper.

Three hours allowed for this paper.

Ordinary or Pass Grale.

1. Point out the difference between conduction and induction across air in a thunderstorm.
2. Describe the character, preservation, and erection of an ordinary wooden telegraph pole.
3. Describe and illustrate a Morse sounder circuit joined up for double current working.
4. Describe any telephone, and show how it is connected up for speaking.
5. Describe Grove's cell, how it is made up, and how it works.
6. Describe any form of telegraph which can be worked without a battery.
7. What is the block system, and how is it worked?
8. To whom are we indebted for the introduction of telegraphy into practical use, and when?
9. Show how aërial lines are insulated.
10. Why is the earth used so much to complete a circuit?

Honours Grade.

1. Describe the modern system of electrical measurement, and detail the different units in use.
2. Describe the full equipment of a testing table for testing ordinary land telegraphs.
3. Explain the tests for conductivity and insulation, and show how to measure the strength of received currents.
4. Describe Bell's telephone, and show how speech is reproduced at a distance by its agency.
5. What is duplex telegraphy, and how is it effected?
6. There have been several magnetic storms this year. To what are they due, and how do they affect telegraphs?
7. How is their disturbing influence on telegraphs remedied?
8. The conductor of an Atlantic cable broke inside its insulating sheath without making any earth whatever. How was the locality of the rupture determined?
9. It is required to measure the electromotive force and internal resistance of a battery of many cells. How would you do it?
10. What are the mechanical and electrical tests applied to ron wire to determine its quality?

22c.—ELECTRICAL INSTRUMENT MAKING.

Instructions.

The candidate must confine himself to one grade only, the Ordinary or Honours, and must state at the top of his paper of answers which grade he has selected. He must *not* answer questions in more than one grade.

This examination is for the purpose of ascertaining whether the candidate has intelligently noted the methods employed in the workshop in the construction of electrical apparatus, and whether he has endeavoured to ascertain the scientific reasons for the processes followed.

The number of the question must be placed before the answer in the worked paper.

Each candidate is supplied with a sheet of ruled squared paper.

Three hours allowed for this paper.

Ordinary or Pass Grade.

[Candidates are not expected to answer more than *six* questions, but more may be attempted.]

1. Describe in detail the construction of a permanent magnet, mentioning the process of magnetising least likely to produce consequent poles, and the reason of this. Give the approximate chemical constitution of the steel you would employ. From what parts of Europe is the best magnet-steel obtainable?
2. Describe the construction of a Jamin magnet, especially the mode employed for putting the component magnets into the iron shoe, so as not to weaken the magnets, and give the reason for the method followed.
3. Draw curves showing the distribution of magnetism along the edge of a bar magnet of rectangular section, as well as along the central line.
4. For making the cores of electro-magnets what is the best iron to be employed, and what is the detailed process to be followed to render the iron most effective? Compare the strength of an electro-magnet when wrought iron, cast iron, or steel are respectively used for the core, other things remaining the same.
6. You are required to design an electro-magnet to record by the motion of its armature, the *exact moment* of making and breaking an electric current. Explain very fully, with sketches, the size and shape of the electro-magnet and armature you would employ.
7. Explain shortly, giving sketches, the difference between (*a*) absolute, (*b*) sensitive, (*c*) dead-beat, (*d*) astatic, and (*e*) differential galvanometers. What are the various methods employed for rendering a galvanometer dead-beat, and which do you consider the best? Mention the full reasons for your answer. Describe with drawings the complete operation of winding and testing a differential galvanometer.
8. The deflection of the needle of a galvanometer is not, as a rule, proportional to the strength of the current. Explain various methods of ascertaining experimentally the connection between different currents and the deflections they respectively produce. Show clearly what is the least amount of apparatus you must employ for carrying out each method. In what way would it be best for a maker of a galvanometer to record, for the benefit of the purchaser, the law connecting deflection with current?
9. Compare the relative advantages and disadvantages of a Grove, Daniell, and Menotti cell, and explain exactly in what cases you would employ each. How many Menotti's cells, each having $7\frac{1}{2}$ ohms resistance, must be employed so that the battery has 11 volts electromotive force and 17 ohms internal resistance? What current in amperes will this battery send through a wire 400 ohms in resistance, with an electro-magnet of 100 ohms resistance at its distant end? How will the total current be changed if a leak of 700 ohms be inserted in the middle of the line wire, and what will be the current now flowing through the distant electro-magnet?
10. Give a drawing of a shunt box having high insulation. Prove what should be the resistance of three shunts so that $\frac{1}{10}$th, $\frac{1}{100}$th, $\frac{1}{1000}$th of the total current passes through a galvanometer of 6,000 ohms resistance. Describe the simplest method of testing with accuracy the coils of the shunt. What kind of wire would you use for the shunts, how would you wind it, and where would you place it to diminish the temperature error as much as possible?
11. Describe, with sketches, the best form of Holtz's electrical machine with which you are acquainted. Explain clearly the principle of its action, and show exactly what is necessary in order that the machine may start at any time without a charge being given to it,
12. For what object is a condenser attached to the primary circuit of a Ruhmkoff coil? Show by a sketch exactly how it must be attached to fulfil this object. If the opposite coatings of a condenser be attached to the ends of the secondary coil, what effect has this on the spark?

Honours Grade.

[Candidates are not expected to answer more than *seven* questions, but more may be attempted.]

1, 2, 3. The same as in the pass examination.
4. What is the law connecting the strength of a straight electro-magnet with its length, the diameter of the core, the material composing the core, the number of turns of wire, and the current? Explain what are the limitations, and the reasons for such limitations, in the use of this formula. Compare the strength of an electro-magnet when wrought iron, cast iron, and steel are respectively used for the core, other things remaining the same.
5. Define intensity of magnetisation. What is about the maximum intensity of magnetisation that can be practically given to a long, thin, hard steel bar?
6. What is your practical experience in the use of iron wire for electro-magnets? In what cases would you employ a compound electro-magnet, consisting of a number of concentrically-coiled iron tubes? Give your full reasons.

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7. What is the best ratio for the diameter of the core of an electro-magnet compared with the diameter of the coil (1st) for weak currents, (2nd) for strong currents? Prove your rule.

8. A horse-shoe electro-magnet has two bobbins, each 3 inches long and 1½ inch external diameter. If the diameter of the core is one-third of an inch, the resistance of the remainder of the circuit 500 ohms, and the resistance of a cubic inch of pure copper 0·63 microhms, what gauge of copper wire, having 95 per cent. of the conductivity of pure copper, would you wind on if the thickness of the silk were neglected? How exactly would you modify your answer in practice to allow for the insulating covering?

9. If the solid iron core in an electro-magnet be replaced with a hollow one, or with a hollow one fitted with an iron cap, what change is produced in the resultant magnetic force (1st) at a point close to the end of the core; (2nd) at a distant point?

10. Define an ohm, a volt, an ampere, and a coulomb. You are required to make an ohm coil as accurately as possible. What difference exactly would you make between it and the standard ohm coil you possess, so as to allow for the result of the most recent experiments on the error of the practical ohm? Explain how you would experimentally graduate a galvanometer so that the number of amperes corrresponding with any deflection should be known. How would you practically arrange a galvanometer so that the same connection between amperes and degrees of deflection should apply for different positions of the instrument?

11. Explain shortly, giving sketches, the difference between (*a*) absolute, (*b*) sensitive, (*c*) dead-beat, (*d*) astatic, and (*e*) differential galvanometers. Give full drawings of a dead-beat galvanometer designed on what you consider the best principles.

12. A tangent galvanometer is one foot in diameter, and has two 'convolutions of wire. If the horizontal intensity of the earth's magnetic force is 0·1813 (C.G.S.), how many amperes are necessary to produce a deflection of 45 deg.? If the galvanometer has also a second coil of fifty convolutions, with a mean diameter of six inches, show exactly how, by means of a Daniell cell and a resistance box, you could check your previous result.

13. Describe in detail and give sketches of instruments for measuring large currents and large electromotive forces—(1st) when the currents and electromotive forces are continuous, (2nd) when they are rapidly reversed. Compare the advantages and disadvantages of the various forms of instruments.

14. What is an electrometer? Give the detailed construction of some sensitive one, with sketches of the various parts of the instrument.

15. Describe the theory and practical construction of a "constant current shunt;" that is, one which shunts the current passing through the galvanometer without altering the total current flowing in the circuit. Give numerical examples.

16. What is an "artifical submarine cable?" How exactly is it made, and what is its use?

17. Why exactly is there practically no spark between the terminals of a Ruhmkoff coil on making the primary circuit, although a bright spark occurs on breaking? The terminals of a secondary coil are joined together so that the circuit is complete, and the primary circuit is first made and then broken. Compare the total quantity of electricity which passes through the secondary coil in the two cases.

BRITISH ASSOCIATION.

Presidential Address by C. William Siemens, D.C.L. (Oxon), LL.D. (Glasc. and Dubl.), Ph.D., F.R.S., F.C.S., Member Inst. C.E.

In venturing to address the British Association from this chair, I feel that I have taken upon myself a task involving very serious responsibility. The Association has for half a century fulfilled the important mission of drawing together, once every year, scientists from all parts of the country for the purpose of discussing questions of mutual interest, and of cultivating those personal relations which aid so powerfully in harmonising views, and in stimulating concerted action for the advancement of science.

A sad event casts a shadow over our gathering. While still mourning the irreparable loss science had sustained in the person of Charles Darwin, whose bold conceptions, patient labour, and genial mind made him almost a type of unsurpassed excellence, telegraphic news reached Cambridge, just a month ago, to the effect that our honorary secretary, Professor F. M. Balfour, had lost his life during an attempted ascent of the Aiguille Blanche de Penteret. Although only 30 years of age, few men have won distinction so rapidly and so deservedly. After attending the lectures of Michael Foster, he completed his studies of biology under Dr. Anton Dohrn at the Zoological Station of Naples in 1875. In 1878 he was elected a Fellow, and in November last a member of Council of the Royal Society, when he was also awarded one of the Royal Medals for his embryological researches. Within a short interval of time Glasgow University conferred on him their honorary degree of LL.D., he was elected President of the Cambridge Philosophical Society, and after having declined very tempting offers from the Universities of Oxford and Edinburgh, he accepted a professorship of animal morphology created for him by his own University. Few men could have borne without hurt such a stream of honourable distinctions, but in young Balfour genius and independence of thought were happily blended with industry and personal modesty; these won for him the friendship, esteem, and admiration of all who knew him.

Since the days of the first meeting of the Association in York in 1831, great changes have taken place in the means at our disposal for exchanging views, either personally or through the medium of type. The creation of the railway system has enabled congenial minds to attend frequent meetings of those special societies which have sprung into existence since the foundation of the British Association, amongst which I need only name here the Physical, Geographical, Meteorological, Anthropological, and Linnean, cultivating abstract science, and the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, the Society of Telegraph Engineers and Electricians, the Gas Institute, the Sanitary Institute, and the Society of Chemical Industry, representing applied science. These meet at frequent intervals in London, whilst others, having similar objects in view, hold their meetings at the University towns, and at other centres of intelligence and industry throughout the country, giving evidence of great mental activity, and producing some of those very results which the founders of the British Association wished to see realised. If we consider further the extraordinary development of scientific journalism which has taken place, it cannot surprise us when we meet with expressions of opinion to the effect that the British Association has fulfilled its mission, and should now yield its place to those special societies it has served to call into existence. On the other hand, it may be urged that the brilliant success of last year's anniversary meeting, enhanced by the comprehensive address delivered on that occasion by my distinguished predecessor in office, Sir John Lubbock, has proved, at least, that the British Association is not dead in the affections of its members, and it behoves us at this, the first ordinary gathering in the second half century, to consider what are the strong points to rely upon for the continuance of a career of success and usefulness.

If the facilities brought home to our doors of acquiring scientific information have increased, the necessities for scientific inquiry have increased in a greater ratio. The time was when science was cultivated only by the few, who looked upon its application to the arts and manufactures as almost beneath their consideration; this they were content to leave in the hands of others, who, with only commercial aims in view, did not aspire to further the objects of science for its own sake, but thought only of benefiting by its teachings. Progress could not be rapid under this condition of things, because the man of pure science rarely pursued his inquiry beyond the mere enunciation of a physical or chemical principle, whilst the simple practitioner was at a loss how to harmonise the new knowledge with the stock of information which formed his mental capital in trade.

The advancement of the last fifty-years has, I venture to submit, rendered theory and practice so independent that an intimate union between them is a matter of absolute necessity for our future progress. Take, for instance, the art of dyeing, and we find that the discovery of new colouring matters derived from waste products, such as coal-tar, completely changes its practice, and renders an intimate knowledge of the science of chemistry a matter of absolute necessity to the practitioner. In telegraphy and in the new arts of applying electricity to lighting, to the transmission of power, and to metallurgical operations, problems arise at every turn, requiring for their solution not only an intimate acquaintance with, but a positive advance upon, electrical science, as established by purely theoretical research in the laboratory. In general engineering the mere practical art of constructing a machine so designed and proportioned as to produce mechanically the desired effect would suffice no longer. Our increased knowledge of the nature of the mutual relations between the different forms of energy makes us see clearly what are the theoretical limits of effect; these, although beyond our absolute reach, may be looked upon as the asymptotes to be approached indefinitely by the hyperbolic course of practical progress, of which we should never lose sight. Cases arise, moreover, where the introduction of new materials of construction, or the call for new effects, renders former rules wholly

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insufficient. In all these cases practical knowledge has to go hand in hand with advanced science in order to accomplish the desired end.

Far be it from me to think lightly of the ardent students of nature, who, in their devotion to research, do not allow their minds to travel into the regions of utilitarianism and of self-interest. These, the high priests of science, command our utmost admiration; but it is not to them that we can look for our current progress in practical science, much less can we look for it to the "rule of thumb" practitioner, who is guided by what comes nearer to instinct than to reason. It is to the man of science, who also gives attention to practical questions, and to the practitioner, who devotes part of his time to the prosecution of strictly scientific investigations, that we owe the rapid progress of the present day, both merging more and more into one class, that of pioneers in the domain of nature. It is such men that Archimedes must have desired when he refused to teach his disciples the art of constructing his powerful ballistic engines, exhorting them to give their attention to the principles involved in their construction, and that Telford, the founder of the Institution of Civil Engineers, must have had in his mind's eye, when he defined civil engineering as the "art of directing the great sources of power in nature."

These considerations may serve to show that although we see the men of both abstract and applied science group themselves in minor bodies for the better prosecution of special objects, the points of contact between the different branches of knowledge are ever multiplying, all tending to form part of a mighty tree—the tree of modern science—under whose ample shadow its cultivators will find it both profitable and pleasant to meet at least once a year; and considering that this tree is not the growth of one country only, but spreads both its roots and branches far and wide, it appears desirable that at these yearly gatherings other nations should be more fully represented than has hitherto been the case. The subjects discussed at our meetings are without exception of general interest, but many of them bear an international character, such as the systematic collection of magnetic, astronomical, meteorological, and geodetical observations, the formation of a universal code for signalling at sea, and for distinguishing lighthouses, and especially the settlement of scientific nomenclatures and units of measurement, regarding all of which an international accord is a matter of the utmost practical importance.

As regards the measures of length and weight it is to be regretted that this country still stands aloof from the movement initiated in France towards the close of last century; but, considering that in scientific work metrical measure is now almost universally adopted, and that its use has been already legalised in this country, I venture to hope that its universal adoption for commercial purposes will soon follow as a matter of course. The practical advantages of such a measure to the trade of this country would, I am convinced, be very great, for English goods, such as machinery or metal rolled to current sections, are now almost excluded from the Continental market, owing to the unit measure employed in their production. The principal impediment to the adoption of the metre consists in the strange anomaly that although it is legal to use that measure in commerce, and although a copy of the standard metre is kept in the Standards' Department of the Board of Trade, it is impossible to procure legalised rods representing it, and to use a non-legalised copy of a standard in commerce is deemed fraudulent. Would it not be desirable that the British Association should endeavour to bring about the use in this country of the metre and kilogramme, and, as a preliminary step, petition the Government to be represented on the International Metrical Commission, whose admirable establishment at Sèvres possesses, independently of its practical work, considerable scientific interest, as a well-found laboratory for developing methods of precise measurement?

Next in importance to accurate measures of length, weight, and time, stand, for the purposes of modern science, those of electricity.

The remarkably clear lines separating conductors from non-conductors of electricity, and magnetic from non-magnetic substances, enable us to measure electrical quantities and effects with almost mathematical precision; and although the ultimate nature of this, the youngest scientifically investigated form of energy, is yet wrapt in mystery, its laws are the most clearly established, and its measuring instruments (galvanometers, electrometers, and magnetometers), are amongst the most accurate in physical science. Nor could any branch of science or industry be named in which electrical phenomena do not occur, to exercise their direct and important influence.

If, then, electricity stands foremost amongst the exact sciences, it follows that its unit measures should be determined with the utmost accuracy. Yet, twenty years ago, very little advance had been made towards the adoption of a rational system. Ohm had, it is true, given us the fixed relations existing between electromotive force, resistance and quantity of current. Joule had established the dynamical equivalent of heat and electricity. and Gauss and Weber had proposed their elaborate system of absolute magnetic measurement. But these invaluable researches appeared only as isolated efforts, when, in 1862, the Electric Unit Committee was appointed by the British Association, at the instance of Sir William Thomson, and it is to the long-continued activity of this committee that the world is indebted for a consistent and practical system of measurement, which, after being modified in details, received universal sanction last year by the International Electrical Congress assembled at Paris.

At this Congress, which was attended officially by the leading physicists of all civilised countries, the attempt was successfully made to bring about a union between the statical system of measurement that had been followed in Germany and some other countries, and the magnetic or dynamical system developed by the British Association, also between the geometrical measure of resistance, the (Werner) Siemens unit, that had been generally adopted abroad, and the British Association unit intended as a multiple of Weber's absolute unit, though not entirely fulfilling that condition. The Congress, while adopting the absolute system of the British Association, referred the final determination of the unit measure of resistance to an International Committee, to be appointed by the representatives of the several Governments; they decided to retain the mercury standard for reproduction and comparison, by which means the advantages of both systems are happily combined, and much valuable labour is utilised; only, instead of expressing electrical quantities directly in absolute measure, the Congress has embodied a consistent system, based on the ohm, in which the units are of a value convenient for practical measurements. In this, which we must hereafter know as the "practical system," as distinguished from the "absolute system," the units are named, all after leading physicists, the ohm, ampere, volt, coulomb, and farad.

I would venture to suggest that two further units might, with advantage, be added to the system decided on by the International Congress at Paris. The first of these is the unit of magnetic quantity or pole. It is of much importance, and few will regard otherwise than with satisfaction the suggestion of Clausius that the unit should be called a "weber," thus retaining a name most closely connected with electrical measurements, and only omitted by the Congress in order to avoid the risk of confusion in the magnitude of the unit. current with which his name had been formerly associated.

The other unit I should suggest adding to the list is that of power. The power conveyed by a current of an ampere through the difference of potential of a volt is the unit consistent with the practical system. It might be appropriately called a watt, in honour of that master mind in mechanical science, James Watt. He it was who first had a clear physical conception of power, and gave a rational method of measuring it. A watt, then, expresses the rate of an ampere multiplied by a volt, whilst a horse-power is 746 watts, and a cheval de vapeur 735.

The system of electro-magnetic units would then be:—

(1) Weber, the unit of magnetic		quantity	$= 10^{8}$	C.G.S. Units.
(2) Ohm	,, ,,	resistance	$= 10^{9}$	,,
(3) Volt	,, ,,	electromotive force	$= 10^{8}$	,,
(4) Ampère	,, ,,	current	$= 10^{-1}$	,,
(5) Coulomb	,, ,,	quantity	$= 10^{-1}$	,,
(6) Watt	,, ,,	power	$= 10^{7}$	,,
(7) Farad	,, ,,	capacity	$= 10^{9}$	,,

Before the list can be looked upon as complete two other units may have to be added, the one expressing that of magnetic field, and the other of heat in terms of the electro-magnetic system. Sir William Thomson suggested the former at the Paris Congress, and pointed out that it would be proper to attach to it the name of Gauss, who first theoretically and practically reduced observations of terrestrial magnetism to absolute measure. A gauss will, then, be defined as the intensity of field produced by a weber at a distance of one centimetre; and the weber will be the absolute C.G.S. unit strength of magnetic pole. Thus the mutual force between two ideal point-poles, each of one weber strength, held at unit distance asunder, will be one degree; that is to say, the force which, acting for a second of time on a gramme of matter, generates a velocity of one centimetre per second.

The unit of heat has hitherto been taken variously as the heat required to raise a pound of water at the freezing-point through 1° Fahrenheit or Centigrade, or, again, the heat necessary to raise a kilogramme of water 1° Centigrade. The inconvenience of a unit so entirely arbitrary is sufficiently apparent to justify the introduction of one based on the electro-magnetic system, viz., the heat generated in one second by the current of an ampere flowing through the resistance of an ohm. In absolute measure its value is 10^{7} C.G.S. units, and, assuming Joule's equivalent as 42,000,000, it is the heat necessary to raise 0·238 grammes of water 1° Centigrade, or, approximately, the $\frac{1}{1000}$th part of the

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arbitary unit of a pound of water raised 1° Fahrenheit and the $\frac{1}{4000}$th of the kilogramme of water raised 1° Centigrade. Such a heat unit, if found acceptable, might with great propriety, I think, be called the joule, after the man who has done so much to develop the dynamical theory of heat.

Professor Clausius urges the advantages of the statical system of measurement for simplicity, and shows that the numerical values of the two systems can readily be compared by the introduction of a factor, which he proposes to call the critical velocity; this Weber has already shown to be nearly the same as the velocity of light. It is not immediately evident how, by the introduction of a simple multiple, signifying a velocity, the statical can be changed into dynamical values, and I am indebted to my friend Sir William Thomson for an illustration which struck me as remarkably happy and convincing. Imagine a ball of conducting matter so constituted that it can at pleasure be caused to shrink. Now let it first be electrified and left insulated with any quantity of electricity on it. After that, let it be connected with the earth by an excessively fine wire or a not perfectly dry silk fibre; and let it shrink just so rapidly as to keep its potential constant, till the whole charge is carried off. The velocity with which its surface approaches its centre is the electrostatic measure of the conducting power of the fibre. Thus we see how "conducting power" is, in electrostatic theory, properly measured in terms of a velocity. Weber had shown how, in electro-magnetic theory, the resistance, or the reciprocal of the conducting power of a conductor, is properly measured by a velocity. The critical velocity, which measures the conducting power in electrostatic reckoning and the resistance in electro-magnetic, of one and the same conductor, measures the number of electrostatic units in the electro-magnetic unit of electric quantity.

Without waiting for the assembling of the International Committee charged with the final determination of the ohm, one of its most distinguished members, Lord Rayleigh, has, with his *collaborateure*, Mrs. Sidgwick, continued his important investigation in this direction at the Cavendish Laboratory, and has lately placed before the Royal Society a result which will probably not be surpassed in accuracy. His redetermination brings him into close accord with Dr. Werner Siemens, their two values of the mercury unit being 0·95418 and 0·9536 of the B.A. unit respectively, or 1 mercury unit = 0·9413 × 10^7 C.G.S. units.

Shortly after the publication of Lord Rayleigh's recent results, Messrs. Glazebrook, Dodds, and Sargant, of Cambridge, communicated to the Royal Society two determinations of the ohm, by different methods; and it is satisfactory to find that their final values differ only in the fourth decimal, the figures being, according to

Lord Rayleigh .... 1 ohm = 0·98651 $\frac{\text{Earth Quadrant}}{\text{Second}}$

Messrs. Glazebrook, &c. = 0·986439 ,,

Professor E. Wiedemann, of Leipzig, has lately called attention to the importance of having the ohm determined in the most accurate manner possible, and enumerates four distinct methods, all of which should unquestionably be tried with a view of obtaining concordant results, because upon its accuracy will depend the whole future system of measurement of energy of whatever form.

The word Energy was first used by Young in a scientific sense, and represents a conception of recent date, being the outcome of the labours of Carnot, Mayer, Joule, Grove, Clausius, Clerk-Maxwell, Thomson, Stokes, Helmholtz, Macquorn-Rankine, and other labourers, who have accomplished for the science regarding the forces in Nature what we owe to Lavoisier, Dalton, Berzelius, Liebig, and others, as regards Chemistry. In this short word Energy we find all the efforts in nature, including electricity, heat, light, chemical action, and dynamics, equally represented, forming, to use Dr. Tyndall's apt expression, so many "modes of motion." It will readily be conceived that when we have established a fixed numerical relation between these different modes of motion, we know beforehand what is the utmost result we can possibly attain in converting one form of energy into another, and to what extent our apparatus for effecting the conversion falls short of realising it. The difference between ultimate theoretical effect and that actually obtained is commonly called loss, but, considering that energy is indestructible, this represents really secondary effect which we obtain without desiring it. Thus friction in the working parts of a machine represents a loss of mechanical effect, but is a gain of heat, and in like manner the loss sustained in transferring electrical energy from one point to another is accounted for by heat generated in the conductor. It sometimes suits our purpose to augment the transformation of electrical into heat energy at certain points of the circuit when the heat rays become visible, and we have the incandescence electric light. In effecting a complete severance of the conductor for a short distance, after the current has been established, a very great local resistance is occasioned, giving rise to the electric arc, the highest development of heat ever attained. Vibration is another form of lost energy in mechanism, but who would call it a loss if it proceeded from the violin of a Joachim or a Norman-Neruda?

Electricity is the form of energy best suited for transmitting an effect from one place to another; the electric current passes through certain substances—the metals—with a velocity limited only by the retarding influence caused by electric charge of the surrounding dielectric, but approaching probably under favourable conditions that of radiant heat and light, or 300,000 kilometres per second; it refuses, however, to pass through oxidised substances, glass, gums, or through gases except when in a highly rarefied condition. It is easy, therefore, to confine the electric current within bounds, and to direct it through narrow channels of extraordinary length. The conducting wire of an Atlantic cable is such a narrow channel; it consists of a copper wire, or strand of wires, 5mm. in diameter, by nearly 5,000 kilometres in length, confined electrically by a coating of gutta percha about 4 mm. in thickness. The electricity from a small galvanic battery passing into this channel prefers the long journey to America in the good conductor, and back through the earth, to the shorter journey across the 4mm. in thickness of insulating material. By an improved arrangement, the alternating currents employed to work long submarine cables do not actually complete the circuit, but are merged in a condenser at the receiving station after having produced their extremely slight but certain effect upon the receiving instrument, the beautiful syphon recorder of Sir William Thomson. So perfect is the channel, and so precise the action of both the transmitting and receiving instruments employed, that two systems of electric signals may be passed simultaneously through the same cable in opposite directions, producing independent records at either end. By the application of this duplex mode of working to the Direct United States cable under the superintendence of Dr. Muirhead, its transmitting power was increased from twenty-five to sixty words a minute, being equivalent to about twelve currents or primary impulses per second. In transmitting these impulse-currents simultaneously from both ends of the line, it must not be imagined, however, that they pass each other in the manner of liquid waves belonging to separate systems; such a supposition would involve momentum in the electric flow, and although the effect produced is analogous to such an action, it rests upon totally different grounds—namely, that of a local circuit at each terminus being called into action automatically whenever two similar currents are passed into the line simultaneously from both ends. In extending this principle of action quadruplex telegraphy has been rendered possible, although not yet for long submarine lines.

The minute currents here employed are far surpassed as regards delicacy and frequency by those revealed to us by that marvel of the present day, the telephone. The electric currents caused by the vibrations of a diaphragm acted upon by the human voice, naturally vary in frequency and intensity according to the number and degree of those vibrations, and each motor current in exciting the electro-magnet forming part of the receiving instrument, deflects the iron diaphragm occupying the position of an armature to a greater or smaller extent according to its strength. Savart found that the fundamental *la* springs from 440 complete vibrations in a second, but what must be the frequency and modulations of the motor current and of magnetic variations necessary to convey to the ear through the medium of a vibrating armature, such a complex of human voices and of musical instruments as constitutes an opera performance. And yet such performances could be distinctly heard and even enjoyed as an artistic treat by applying to the ears a pair of the double telephonic receivers at the Paris Electrical Exhibition, when connected with a pair of transmitting instruments in front of the footlights of the Grand Opera. In connection with the telephone, and with its equally remarkable adjunct the microphone, the names of Reiss, Graham Bell, Edison, and Hughes will ever be remembered.

Considering the extreme delicacy of the currents working a telephone, it is obvious that those caused by induction from neighbouring telegraphic line wires would seriously interfere with the former, and mar the speech or other sounds produced through their action. To avoid such interference, the telephone wires, if suspended in the air, require to be placed at some distance from telegraphic line wires, and to be supported by separate posts. Another way of neutralising interference consists in twisting two separately insulated telephone wires together, so as to form a strand, and in using the two conductors as a metallic circuit to the exclusion of the earth; the working current will, in that case, receive equal and opposite inductive influences, and will therefore remain unaffected by them. On the other hand two insulated wires, instead of one, are required for working one set of instruments; and a serious increase in the cost of installa-

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tion is thus caused. To avoid this Mr. Jacob has lately suggested a plan of combining pairs of such metallic circuits again into separate working pairs, and these again with other working pairs, whereby the total number of telephones capable of being worked without interference is made to equal the total number of single wires employed. The working of telephones and telegraphs in metallic circuit has the further advantage that mutual volta induction between the outgoing and returning currents favours the transit, and neutralises on the other hand the retarding influence caused by charge in underground or submarine conductors. These conditions are particularly favourable to underground line wires, which possess other important advantages over the still prevailing overground system, in that they are unaffected by atmospheric electricity, or by snowstorms and heavy gales, which at not very rare intervals of time put us back to pre-telegraphic days, when the letter carrier was our swiftest messenger.

The underground system of telegraphs, first introduced into Germany by Werner Siemens in the years 1847-8, had to yield for a time to the overground system owing to technical difficulties, but it has been again resorted to within the last four years, and multiple land cables of solid construction now connect all the important towns of that country. The first cost of such a system is, no doubt, considerable (being about £38 per kilometre of conductor as against £8 10s. the cost of land lines); but as the underground wires are exempt from frequent repairs and renewals, and as they insure continuity of service, they are decidedly the cheaper and better in the end. The experience afforded by the early introduction of the underground system in Germany was not, however, without its beneficial results, as it brought to light the phenomena of lateral induction, and of faults in the insulating coating, matters which had to be understood before submarine telegraphy could be attempted with any reasonable prospect of success.

Regarding the transmission of power to a distance, the electric current has now entered the lists in competition with compressed air, the hydraulic accumulator, and the quick running rope as used at Schaffhausen to utilise the power of the Rhine fall. The transformation of electrical into mechanical energy can be accomplished with no further loss than is due to such incidental causes as friction and the heating of wires; these in a properly designed dynamo-electric machine do not exceed 10 per cent., as shown by Dr. John Hopkinson, and, judging from recent experiments of my own, a still nearer approach to ultimate perfection is attainable. Adhering, however, to Dr. Hopkinson's determination for safety's sake, and assuming the same percentage in reconverting the current into mechanical effect, a total loss of 19 per cent. results. To this loss must be added that through electrical resistance in the connecting line wires, which depends upon their length and conductivity, and that due to heating by friction of the working parts of the machine. Taking these as being equal to the internal losses incurred in the double process of conversion, there remains a useful effect of $100 - 38 = 62$ per cent., attainable at a distance, which agrees with experimental results, although in actual practice it would not be safe at present to expect more than 50 per cent. of ultimate useful effect, to allow for all mechanical losses.

In using compressed air or water for the transmission of power the loss cannot be taken at less than 50 per cent., and as it depends upon fluid resistance it increases with distance more rapidly than in the case of electricity. Taking the loss of effect in all cases as 50 per cent., electric transmission presents the advantage that an insulated wire does the work of a pipe capable of withstanding high internal pressure, which latter must be more costly to put down and to maintain. A second metallic conductor is required, however, to complete the electrical circuit, as the conducting power of the earth alone is found unreliable for passing quantity currents, owing to the effects of polarisation; but as this second conductor need not be insulated, water or gas pipes, railway metals or fencing wire, may be called into requisition for the purpose. The small space occupied by the electro-motor, its high working speed, and the absence of waste products, render it specially available for the general distribution of power to cranes and light machinery of every description. A loss of effect of 50 per cent. does not stand in the way of such applications, for it must be remembered that a powerful central engine of best construction produces motive power with a consumption of two pounds of coal per horse-power per hour, whereas small engines distributed over a district would consume not less than five; we thus see that there is an advantage in favour of electric transmission as regards fuel, independently of the saving of labour and other collateral benefits.

To agriculture, electric transmission of power seems well adapted for effecting the various operations of the farm and fields from one centre. Having worked such a system myself in combination with electric lighting and horticulture for upwards of two years, I can speak with confidence of its economy, and of the facility with which the work is accomplished in charge of untrained persons.

As regards the effect of the electric light upon vegetation there is little to add to what was stated in my paper read before Section A last year, and ordered to be printed with the report, except that in experimenting upon wheat, barley, oats, and other cereals sown in the open air, there was a marked difference between the growth of the plants influenced and those uninfluenced by the electric light. This was not very apparent till towards the end of February, when, with the first appearance of mild weather, the plants under the influence of an electric lamp of 4,000 candle-power placed about five metres above the surface, developed with extreme rapidity, so that by the end of May they stood above four feet high, with the ears in full bloom, when those not under its influence were under two feet in height, and showed no sign of the ear.

In the electric railway first constructed by Dr. Werner Siemens, at Berlin, in 1879, electric energy was transmitted to the moving carriage or train of carriages through the two rails upon which it moved, these being sufficiently insulated from each other by being placed upon well creosoted cross sleepers. At the Paris Electrical Exhibition the current was conveyed through two separate conductors making sliding or rolling contact with the carriage, whereas in the electric railway now in course of construction in the north of Ireland (which when completed will have a length of twelve miles) a separate conductor will be provided by the side of the railway, and the return circuit completed through the rails themselves, which in that case need not be insulated; secondary batteries will be used to store the surplus energy created in running downhill, to be restored in ascending steep inclines, and for passing roadways where the separate insulated conductor is not practicable. The electric railway possesses great advantages over horse or steam-power for towns, in tunnels, and in all cases where natural sources of energy, such as waterfalls, are available; but it would not be reasonable to suppose that it will in its present condition compete with steam propulsion upon ordinary railways. The transmission of power by means of electric conductors possesses the further advantage over other means of transmission that, provided the resistance of the rails be not very great, the power communicated to the locomotive reaches its maximum when the motion is at its minimum—that is, in commencing to work, or when encountering an exceptional resistance—whereas the utmost economy is produced in the normal condition of working when the velocity of the power-absorbing nearly equals that of the current-producing machine.

The deposition of metals from their solutions is perhaps the oldest of all useful applications of the electric current, but it is only in very recent times that the dynamo current has been practically applied to the refining of copper and other metals, as now practised at Birmingham and elsewhere, and upon an exceptionally large scale at Ocker, in Germany. The dynamo machine there employed was exhibited at the Paris Electrical Exhibition by Dr. Werner Siemens, its peculiar feature being that the conductors upon the rotating armature consisted of solid bars of copper 30mm. square, in section, which were found only just sufficient to transmit the large quantity of electricity of low tension necessary for this operation. One such machine consuming 4 horse-power deposits about 300 kilogrammes of copper per 24 hours; the motive power at Ocker is derived from a waterfall.

Electric energy may also be employed for heating purposes, but in this case it would obviously be impossible for it to compete in point of economy with the direct combustion of fuel for the attainment of ordinary degrees of heat. Bunsen and St. Claire de Ville have taught us, however, that combustion becomes extremely sluggish when a temperature of 1,800° C. has been reached, and for effects at temperatures exceeding that limit the electric furnace will probably find advantageous applications. Its specific advantage consists in being apparently unlimited in the degree of heat attainable, thus opening out a new field of investigation to the chemist and the metallurgist. Tungsten has been melted in such a furnace, and eight pounds of platinum have been reduced from the cold to the liquid condition in 20 minutes.

The largest and most extensive application of electric energy at the present time is to lighting, but, considering how much has of late been said and written for and against this new illuminant, I shall here confine myself to a few general remarks. Joule has shown that if an electric current is passed through a conductor the whole of the energy lost by the current is converted into heat; or, if the resistance be localised, into radiant energy comprising heat, light, and actinic rays. Neither the low heat rays nor the ultra-violet of highest refrangibility affect the retina, and may be regarded as lost energy, the effective rays being those between the red and violet of the spectrum, which in their combination produce the effect of white light.

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Regarding the proportion of luminous to non-luminous rays proceeding from an electric arc or incandescent wire, we have a most valuable investigation by Dr. Tyndall, recorded in his work on "Radiant Heat." Dr. Tyndall shows that the luminous rays from a platinum wire heated to its highest point of incandescence, which may be taken at 1,700° C., formed $\frac{1}{24}$th part of the total radiant energy emitted, and $\frac{1}{10}$th part in the case of an arc light worked by a battery of 50 Grove elements. In order to apply these valuable data to the case of electric lighting by means of dynamo-currents, it is necessary in the first place to determine what is the power of 50 Grove elements of the size used by Dr. Tyndall, expressed in the practical scale of units as now established. From a few experiments lately undertaken for myself, it would appear that 50 such cells have an electromotive force of 98·5 volts, and an internal resistance of 13·5 ohms, giving a current of 7·3 amperes when the cells are short-circuited. The resistance of a regulator such as Dr. Tyndall used in his experiments may be taken at 10 ohms, the current produced in the arc would be $\frac{98\cdot5}{13\cdot5 + 10 + 1} = 4$ amperes (allowing one ohm for the leads), and the power consumed $10 \times 4^2 = 160$ watts; the light power of such an arc would be about 150 candles, and, comparing this with an arc of 3,308 candles produced by 1,162 watts, we find that $\left(\frac{1162}{160}\right)$, *i.e.*, 7·3 times the electric energy produce $\left(\frac{3308}{150}\right)$, *i.e.*, 22 times the amount of light measured horizontally. If, therefore, in Dr. Tyndall's arc $\frac{1}{10}$th of the radiant energy emitted was visible as light, it follows that in a powerful arc of 3,300 candles, $\frac{1}{10} \times \frac{22\cdot0}{7\cdot3}$, or fully $\frac{1}{3}$, are luminous rays. In the case of the incandescence light (say a Swan light of 20 candle-power) we find in practice that nine times as much power has to be expended as in the case of the arc light; hence $\frac{1}{3} \times \frac{1}{9} = \frac{1}{27}$ part of the power is given out as luminous rays, as against $\frac{1}{24}$th in Dr. Tyndall's incandescent platinum—a result sufficiently approximate considering the wide difference of conditions under which the two are compared.

These results are not only of obvious practical value, but they seem to establish a fixed relation between current, temperature, and light produced, which may serve as a means to determine temperatures exceeding the melting point of platinum with greater accuracy than has hitherto been possible by actinimetric methods in which the thickness of the luminous atmosphere must necessarily exercise a disturbing influence. It is probably owing to this circumstance that the temperature of the electric arc as well as that of the solar photosphere has frequently been greatly over-estimated.

The principal argument in favour of the electric light is furnished by its immunity from products of combustion which not only heat the lighted apartments, but substitute carbonic acid and deleterious sulphur compounds for the oxygen upon which respiration depends; the electric light is white instead of yellow, and thus enables us to see pictures, furniture, and flowers as by daylight; it supports growing plants instead of poisoning them, and by its means we can carry on photography and many other industries at night as well as during the day. The objection frequently urged against the electric light, that it depends upon the continuous motion of steam or gas engines, which are liable to accidental stoppage, has been removed by the introduction into practical use of the secondary battery; this, although not embodying a new conception, has lately been greatly improved in power and constancy by Planté, Faure, Volckmar, Sellon, and others, and promises to accomplish for electricity what the gas-holder has done for the supply of gas and the accumulator for hydraulic transmission of power.

It can no longer be a matter of reasonable doubt, therefore, that electric lighting will take its place as a public illuminant, and that even though its cost should be found greater than that of gas, it will be preferred for the lighting of drawing rooms and dining rooms, theatres, and concert rooms, museums, churches, warehouses, show rooms, printing establishments and factories, and also the cabins and engine rooms of passenger steamers. In the cheaper and more powerful form of the arc light, it has proved itself superior to any other illuminant for spreading artificial daylight over the large areas of harbours, railway stations, and the sites of public works. When placed within a holophote the electric lamp has already become a powerful auxiliary in effecting military operations both by sea and land.

The electric light may be worked by natural sources of power, such as waterfalls, the tidal wave, or the wind, and it is conceivable that these may be utilised at considerable distances by means of metallic conductors. Some five years ago I called attention to the vastness of those sources of energy, and the facility offered by electrical conduction in rendering them available for lighting and power supply, while Sir William Thomson made this important matter the subject of his admirable address to Section A last year at York, and dealt with it in an exhaustive manner.

The advantages of the electric light and of the distribution of power by electricity have lately been recognised by the British Government, who have just passed a Bill through Parliament to facilitate the establishment of electrical conductors in towns, subject to certain regulating clauses to protect the interests of the public and of local authorities. Assuming the cost of electric light to be practically the same as gas, the preference for one or other will in each application be decided upon grounds of relative convenience, but I venture to think that gas lighting will hold its own as the poor man's friend.

Gas is an institution of the utmost value to the artisan; it requires hardly any attention, is supplied upon regulated terms, and gives with what should be a cheerful light a genial warmth, which often saves the lighting of a fire. The time is, moreover, not far distant, I venture to think, when both rich and poor will largely resort to gas as the most convenient, the cleanest, and the cheapest of heating agents, and when raw coal will be seen only at the colliery or the gasworks. In all cases where the town to be supplied is within, say, thirty miles of the colliery, the gasworks may with advantage be planted at the mouth, or still better, at the bottom of the pit, whereby all haulage of fuel would be avoided, and the gas, in its ascent from the bottom of the colliery, would acquire an onward pressure sufficient probably to impel it to its destination. The possibility of transporting combustible gas through pipes for such a distance has been proved at Pittsburg, where natural gas from the oil district is used in large quantities.

The quasi monopoly so long enjoyed by gas companies has had the inevitable effect of checking progress. The gas being supplied by meter, it has been seemingly to the advantage of the companies to give merely the prescribed illuminating power, and to discourage the invention of economical burners, in order that the consumption might reach a maximum. The application of gas for heating purposes has not been encouraged, and is still made difficult in consequence of the objectionable practice of reducing the pressure in the mains during daytime to the lowest possible point consistent with prevention of atmospheric indraught. The introduction of the electric light has convinced gas managers and directors that such a policy is no longer tenable, but must give way to one of technical progress; new processes for cheapening the production and increasing the purity and illuminating power of gas are being fully discussed before the Gas Institute; and improved burners, rivalling the electric light in brilliancy, greet our eyes as we pass along our principal thoroughfares.

Regarding the importance of the gas supply as it exists at present, we find from a Government return that the capital invested in gasworks in England, other than those of local authorities, amounts to £30,000,000; in these 4,281,048 tons of coal are converted annually, producing 43,000 million cubic feet of gas, and about 2,800,000 tons of coke; whereas the total amount of coal annually converted in the United Kingdom may be estimated at 9,000,000 tons, and the by-products therefrom at 500,000 tons of tar, 1,000,000 tons of ammonia liquor, and 4,000,000 tons of coke, according to the returns kindly furnished me by the managers of many of the gasworks and corporations. To these may be added say 120,000 tons of sulphur, which up to the present time is a waste product.

Previous to the year 1856—that is to say, before Mr. W. H. Perkin had invented his practical process, based chiefly upon the theoretical investigation of Hoffman, regarding the coal tar bases and the chemical constitution of indigo—the value of coal tar in London was scarcely a halfpenny a gallon, and in country places gas makers were glad to give it away. Up to that time the coal tar industry had consisted chiefly in separating the tar by distillation into naphtha, creosote, oils, and pitch. A few distillers, however, made small quantities of benzene, which had been first shown—by Mansfield, in 1849—to exist in coal tar naphtha mixed with toluene, cumene, &c. The discovery, in 1856, of the mauve or aniline purple gave a great impetus to the coal tar trade, inasmuch as it necessitated the separation of large quantities of benzene, or a mixture of benzene and toluene, from the naphtha. The trade was further increased by the discovery of the magenta or rosaniline dye, which required the same products for its preparation. In the meantime, carbolic acid was gradually introduced into commerce, chiefly as a disinfectant, but also for the production of colouring matter.

The next most important development arose from the discovery by Græbe and Liebermann that alizarine, the colouring principle of the madder root, was allied to anthracene, a hydrocarbon existing in coal tar. The production of this colouring matter from anthracene followed, and is now one of the most important operations connected with tar distilling. The success of the alizarine made in this manner has been so great that

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it has almost entirely superseded the use of madder, which is now cultivated to only a comparatively small extent. The most important colouring matters recently introduced are the azo-scarlets. They have called into use the coal-tar hydrocarbons, xylene and cumene. Naphthalene is also used in their preparation. These splendid dyes have replaced cochineal in many of its applications, and have thus seriously interfered with its use. The discovery of artificial indigo by Professor Baeyer is of great interest. For the preparation of this colouring matter toluene is required. At present artificial indigo does not compete seriously with the natural product; but should it eventually be prepared in quantity from toluene, a further stimulus will be given to the coal-tar trade.

The colour industry utilises even now practically all the benzene, a large proportion of the solvent naphtha, all the anthracene, and a portion of the naphthaline resulting from the distillation of coal-tar; and the value of the colouring matter thus produced is estimated by Mr. Perkin at £3,350,000.

The demand for ammonia may be taken as unlimited, on account of its high agricultural value as a manure; and, considering the failing supply of guano and the growing necessity for stimulating the fertility of our soil, an increased production of ammonia may be regarded as a matter of national importance, for the supply of which we have to look almost exclusively to our gasworks. The present production of 1,000,000 tons of liquor yields 95,000 tons of sulphate of ammonia; which, taken at £20 10s. a ton, represents an annual value of £1,947,000.

The total annual value of the gasworks by-products may be estimated as follows:—

Colouring matter	£3,350,000
Sulphate of ammonia	1,947,000
Pitch (325,000 tons)	365,000
Creosote (25,000,000 gallons)	208,000
Crude carbolic acid (1,000,000 gallons)	100,000
Gas coke, 4,000,000 tons (after allowing 2,000,000 tons consumption in working the retorts) at 12s.	2,400,000
Total	£8,370,000

Taking the coal used, 9,000,000 tons, at 12s., equal £5,400,000, it follows that the by-products exceed in value the coal used by very nearly £3,000,000.

In using raw coal for heating purposes these valuable products are not only absolutely lost to us, but in their stead we are favoured with those semi-gaseous by-products in the atmosphere too well known to the denizens of London and other large towns as smoke. Professor Roberts has calculated that the soot in the pall hanging over London on a winter's day amounts to fifty tons, and that the carbonic oxide, a poisonous compound resulting from the imperfect combustion of coal, may be taken as at least five times that amount. Mr. Aitken has shown, moreover, in an interesting paper communicated to the Royal Society of Edinburgh, last year, that the fine dust resulting from the imperfect combustion of coal is mainly instrumental in the formation of fog; each particle of solid matter attracting to itself aqueous vapour; these globules of fog are rendered particularly tenacious and disagreeable by the presence of tar vapour, another result of imperfect combustion of raw fuel, which might be turned to much better account at the dye works. The hurtful influence of smoke upon public health, the great personal discomfort to which it gives rise, and the vast expense it indirectly causes through the destruction of our monuments, pictures, furniture, and apparel, are now being recognised, as is evinced by the success of recent Smoke Abatement Exhibitions. The most effectual remedy would result from a general recognition of the fact that wherever smoke is produced, fuel is being consumed wastefully, and that all our calorific effects, from the largest down to the domestic fire, can be realised as completely and more economically without allowing any of the fuel employed to reach the atmosphere unburnt. This most desirable result may be effected by the use of gas for all heating purposes with or without the addition of coke or anthracite.

The cheapest form of gas is that obtained through the entire distillation of fuel in such gas producers as are now largely used in working the furnaces of glass, iron, and steel works; but gas of this description would not be available for the supply of towns owing to its bulk, about two-thirds of its volume being nitrogen. The use of water gas, resulting from the decomposition of steam in passing through a hot chamber filled with coke, has been suggested, but this gas also is objectionable, because it contains, besides hydrogen, the poisonous and inodorous gas carbonic oxide, the introduction of which into dwelling houses could not be effected without considerable danger. A more satisfactory mode of supplying heating separately from illuminating gas would consist in connecting the retort at different periods of the distillation with two separate systems of mains for the delivery of the respective gases. Experiments made some years ago by Mr. Ellisen of the Paris gas works have shown that the gases rich in carbon, such as olefiant and acetylene, are developed chiefly during an interval of time, beginning half an hour after the commencement and terminating at half the whole period of distillation, whilst during the remainder of the time marsh gas and hydrogen are chiefly developed, which, while possessing little illuminating power, are most advantageous for heating purposes. By resorting to improved means of heating the retorts with gaseous fuel, such as have been in use at the Paris Gas Works for a considerable number of years, the length of time for effecting each distillation may be shortened from six hours, the usual period in former years, to four, or even three hours, as now practised at Glasgow and elsewhere. By this means a given number of retorts can be made to produce, in addition to the former quantity of illuminating gas of superior quality, a similar quantity of heating gas, resulting in a diminished cost of production and an increased supply of the valuable by-products previously referred to. The quantity of both ammonia and heating gas may be further increased by the simple expedient of passing a streamlet of steam through the heated retorts towards the end of each operation, whereby the ammonia and hydrocarbons still occluded in the heated coke will be evolved, and the volume of heating gas produced be augmented by the products of decomposition of the steam itself. It has been shown that gas may be used advantageously for domestic purposes with judicious management even under present conditions, and it is easy to conceive that its consumption for heating would soon increase, perhaps tenfold, if supplied separately at say 1s. a thousand cubic feet. At this price gas would be not only the cleanest and most convenient, but also the cheapest form of fuel, and the enormous increase of consumption, the superior quality of the illuminating gas obtained by selection, and the proportionate increase of by-products, would amply compensate the gas company or corporation for the comparatively low price of the heating gas.

The greater efficiency of gas as a fuel results chiefly from the circumstance that a pound of gas yields in combustion 22,000 heat units, or exactly double the heat produced in the combustion of a pound of ordinary coal. This extra heating power is due partly to the freedom of the gas from earthy constituents, but chiefly to the heat imparted to it in effecting its distillation. Recent experiments with gas burners have shown that in this direction also there is much room for improvement.

The amount of light given out by a gas flame depends upon the temperature to which the particles of solid carbon in the flame are raised, and Dr. Tyndall has shown that of the radiant energy set up in such a flame, only the 1-25th part is luminous; the hot products of combustion carry off at least four times as much energy as is radiated, so that not more than one hundredth part of the heat evolved in combustion is converted into light. This proportion could be improved, however, by increasing the temperature of combustion, which may be effected either by intensified air currents or by regenerative action. Supposing that the heat of the products of combustion could be communicated to metallic surfaces, and be transferred by conduction or otherwise to the atmospheric air supporting combustion in the flame, we should be able to increase the temperature accumulatively to any point within the limit of dissociation; this limit may be fixed at about 2,300° C., and cannot be very much below that of the electric arc. At such a temperature the proportion of luminous rays to the total heat produced in combustion would be more than doubled, and the brilliancy of the light would at the same time be greatly increased. Thus improved, gas-lighting may continue its rivalry with electric lighting both as regards economy and brilliancy, and such rivalry must necessarily result in great public advantage.

In the domestic grate radiant energy of inferior intensity is required, and I for one do not agree with those who would like to see the open fireplace of this country superseded by the Continental stove. The advantages usually claimed for the open fireplace are, that it is cheerful, "pokable," and conducive to ventilation, but to these may be added another of even greater importance, viz. that the radiant heat which it emits passes through the transparent air without warming it, and imparts heat only to the solid walls, floor, and furniture of the room, which are thus constituted the heating surfaces of the comparatively cool air of the apartments in contact with them. In the case of stoves the heated air of the room causes deposit of moisture upon the walls in heating them, and gives rise to mildew and germs injurious to health. It is, I think, owing to this circumstance that upon entering an apartment one can immediately perceive whether or not it is heated by an open fireplace; nor is the unpleasant sensation due to stove-heating completely removed by mechanical ventilation; there is, moreover, no good reason why an open fireplace should not be made as economical and smokeless as a stove or hot-water apparatus.

(TO BE CONTINUED.)

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THE ELECTRICIAN.

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ELECTRICITY IN THE MANUFACTURES.

We hear every day of the progress of electricity in lighting, or as applied to the telephone and to the telegraph. Even our popular-science writers are beginning to call this the "electrical age;" but it is doubtful whether we have yet entered upon that age. For "to those who know" there appear very many applications of electricity still to be made; and in several instances these applications are merely a question of cost, as, technically, they are practicable now. Cheap electricity a few years ago was unknown, now it is common, and it may be that presently there will be a glut in the market. When that occurs, there will be money in the knowledge of probable applications.

Electricity could be doubtless substituted for iron in the reduction of copper, and will be so employed when the cost of it shall be less than that of the iron now used, or of the lime that can be used with some methods. Copper is, as we know, generally precipitated by throwing sometimes scrap-iron, sometimes pig-iron, into an acid solution of the oxide contained in the ore. This precipitation is accompanied by the evolution of much gas, representing so much waste energy; for although in chemical manufactures we have learned to avoid "waste products," waste of energy is very little, if at all, studied. Plans have been devised for the utilisation of one form of the spare energy now wasted in the precipitation of copper, by causing the electric currents produced in the precipitation tank by the solution of the iron to traverse another precipitation tank where no iron is used, but where, with a system of electrodes, the current causes deposition of the copper. The difficulty attending the process is the compulsory use of an insoluble anode, a veritable *bête-noir* to all electro-metallurgists. We have not seen it suggested to use the electric current so produced to *refine* the crude metal by making this a soluble anode in the well-known way. Nor have we seen it suggested that a storage battery charged by such wasted currents would afford light in the offices and laboratories of the works; yet these ideas are feasible and perhaps even would be profitable.

But to return to actual applications. Not many of our readers may be aware that there are still great improvements needed in the preparation of that familiar metal zinc, and that electricity, in whose cause so much of the metal is consumed, offers a means of obtaining a purer product, as well as a means of extraction from the ore. The trials in this respect are particularly interesting, because zinc is a substance the extraction of which by existing metallurgical operations is very costly. The present method, which consists in the reduction of the zinc by carbon at a certain high temperature, costs about £2 a ton of ore treated. To this must be added about another £1 a ton for loss of metal, so that a 40-50 per cent. ore will average about £3 a ton of ore to reduce. But as most of the ore comes from Greece, Sardinia, or Spain, to be treated at Liege, or Stolberg, or Swansea, another £1 a ton has to be added for freightage of raw material. Again, one ton of ore needs about two tons of coal for the reduction, and in some cases the coal has to be also freighted. If some means are devised for treatment of the ore at the mine, the result must be equally to the advantage of suppliers and consumers, amongst the latter numbering not least the electrician himself. A general plan is to transform the ore into a soluble salt, and reduce the metal in an electrolytic bath.

Zinc ores are two in number: calamine or carbonate of zinc, and blende or sulphide of zinc, both insoluble. One process consists in treating the ore with hydrochloric acid to transform it into a very concentrated neutral hydrated chloride, and this "liquor" is submitted to the action of an electric current, which precipitates the zinc in a state of purity. In this process, to prevent an unwelcome addition of iron in the deposited metal, the iron has to be peroxidised by an energetic oxidising agent, such as nitric acid, and is then preciptated as hydrated peroxide. The positive electrode is made of retort-carbon; at this electrode chlorine is disengaged, and is collected for the manufacture of chloride of lime.

But blende not being soluble in hydrochloric acid, this process applies only to calamine. Hence, it has been suggested to use nitric acid, because this is a solvent of both ores. The metal is then transformed into nitrate, but it then deposits oxide, and the use of organic matter, such as glycerine or glucose, to avoid this deposit, adds considerably to the cost of the process. Another process is to transform the ore into a soluble sulphate, not by the addition of sulphuric acid, but by making the ore itself provide that solvent. The mixed ores are roasted at a moderate temperature, the chief object being the formation of sulphate, but the sulphurous acid transformed into sulphuric acid, is used either to dissolve the calamine or for the sulphating of ores already roasted, but incompletely transformed. The ore under its new form of sulphate is run into tanks with water, whence it passes slowly into the electrolytic tanks. The liquor, charged with sulphate, gradually reaches the lower part of these tanks, and the sulphuric acid set free around the positive electrode arrives at the upper part of the tanks, whence it is diverted into other baths upon material to be dissolved. A cycle of manufacture is thus attained, but the same liquid cannot serve indefinitely, because of the accumulation of foreign substances, such as lime. The negative electrode is a thin plate of zinc, the positive electrode is a plate of lead. On the latter the iron contained in the liquid is deposited as oxide. The lead, silver, and other insoluble metals remain in the sludge or residuum of the tanks.

Of course the electric source, to be as cheaply obtained as possible, necessitates the vicinity of water power. But even where steam power is used the quantity of coal required is about per ton of metal produced what is required by the

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usual process per ton of ore treated—a very considerable economy. The first cost of plant, too—and the plant is of a more durable kind—appears to be much less for the electric process.

Metals are, however, not the only substances open to electrical treatment. Alcohol that, according to some social philosophers, lends itself too readily to anything, is equally adaptable to rectification by electrolysis. That oxygen has an "ageing" effect on alcohol has been long known, and the nascent oxygen generated by the electrolysis of the water of the spirit is found to be very powerful in that effect, very rapid results accruing when the operation is conducted at a proper temperature. A similar process has been applied to the preparation of the derivatives from alcohol, and successfully, at least, in the laboratory. Hydrogen, too, obtained by electrolysis has long been used in the reduction of organic compounds like cinchonine.

In dyeing the electric current would appear to promise usefulness in the production of some of the colouring matters. Insoluble aniline black has been electrically obtained, and quite a collection of electric colours was shown in the Paris exhibition of electrical apparatus. As the colouring matter is set free sometimes at one electrode, sometimes at the other, as the nature of the electrolyte and process may determine, it was necessary to separate the baths into two electrolytic portions by a porous division, or to employ two vessels connected by a thick band of wick, an electrode being placed in each vessel, the circuit being completed, and the division formed by the capillary action of the wick. The substances with which trials have been made are chiefly the salts of aniline, of toluidine, of methylamine, of diphenylamine, and of methyldiphenylamine, phenol, and the salts of naphtylamine. The principal colouring matters prepared thus are:—Aniline black, obtained at the positive pole by electrolysis of an aqueous solution of chlorhydrate, sulphate, or nitrate of aniline, acidulated with sulphuric acid. Several aniline blues, obtained at the positive pole by electrolysis of the chlorhydrates of methylaniline and derivatives. Hofman's violet, obtained at the positive pole of a solution containing osaniline, methylic alcohol, a little sulphuric acid, and small quantities of iodide of potassium. Artificial alizarine, prepared at the negative pole in electrolysing a mixture of anthraquinone with a concentrated solution of caustic potash.

These are, nevertheless, not all the applications of electricity to the manufactures, but only some of the least known; and we have quoted them to show that electricity, whilst so prominently presented now as a luminous agent, or as affording the most economical means of transmitting power, is far from being limited to those important applications.

YOUNG'S PATENT SPEED INDICATOR.

The want of an instrument which will instantaneously and correctly indicate the speed of dynamo-electric and other machines adapted to run at high speeds has been often experienced by engineers and others employing such machines. This want is effectually met by the instrument shown in the annexed illustrations, which is a portable speed indicator, and can be applied to a rotating shaft in the same manner as the counters hitherto employed for ascertaining the speed of dynamo and other machines; it possesses, however, the advantage over the counters, in that it indicates the number of revolutions per minute at a glance, and without the necessity for using a watch or clock in conjunction with it. Owing to its construction, moreover, each little machine can be minutely adjusted during final testing in the manufactory, and its indications may be so correctly fixed that it will show the variations in the speed of a machine caused by the slipping of the belt, a point of great importance to those employing machines for producing the electric light. In addition to the portable form shown, these instruments are made to be permanently attached to the machines. The indications are effected by means of a small high-speed cen-

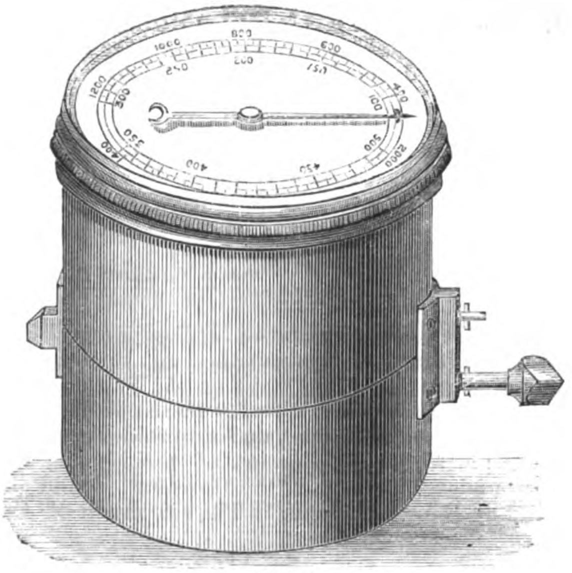


FIG. 1.

trifugal governor, arranged within a casing as shown herewith, and acting upon an index or pointer by means shown in Figs. 2 and 3. Two or more spindles are provided as shown, upon which to place the carrier for thrusting against the end of the shaft. These spindles are fitted with multi-

FIG. 2

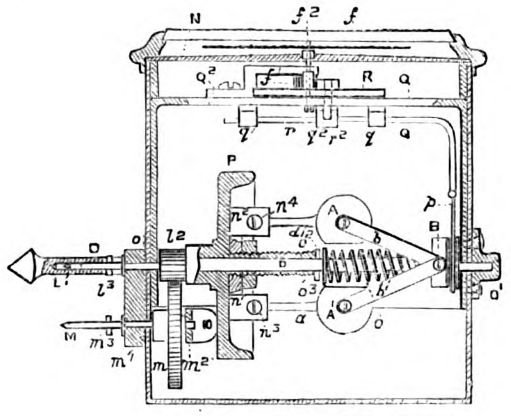
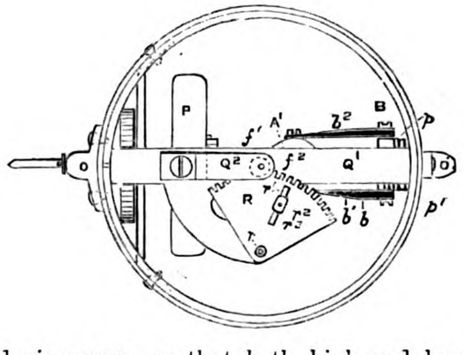


FIG. 3.



plying or reducing gear, so that both high and low speeds can be indicated, the dial having two or more graduated circles for this purpose. A number of these instruments have now been used by some of the leading electrical engineers with great success, and have in every case given satisfaction to those employing them. These speed indicators are manu-

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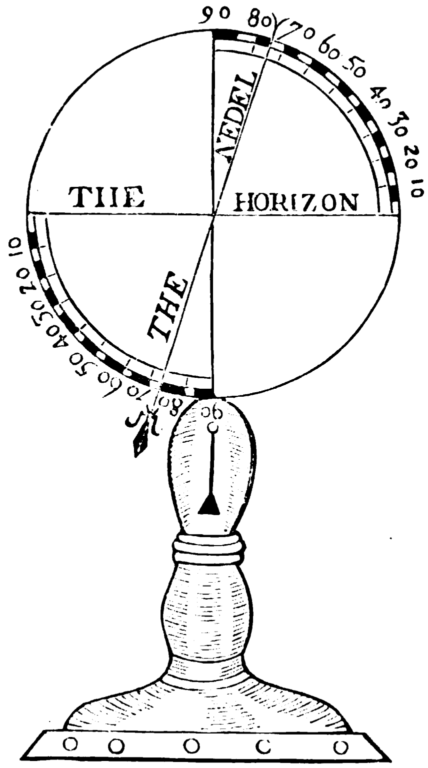
factured in a durable and highly finished form by Messrs. Elliott Brothers, of Charing-cross.

In Figs. 2 and 3, A A^1 are the governor balls provided with arms, a a^1, and connected to arms, b b^1, on the sleeve B. The arms a a^1 are connected to the fly-wheel P by a plate, n, passed over a screwed tube formed on the fly-wheel P until it rests against the fly-wheel, and a nut, n*, is then screwed down over it. The said plate n is formed with lugs, n^1 n^2, for the arms a a^1. The fly-wheel P is fitted upon the spindle D, so that, when the said spindle is rotated, the fly-wheel will be carried round with it by friction as soon as the inertia of the fly-wheel is overcome. The spindle D passes through the casing to receive the carrier L^1. The pinion l^2 is fixed upon the spindle D, and gears with the spur wheel m fixed on the spindle M, in bearings, m^1 m^2.—*Engineer.*

ORIGINAL DISCOVERY OF THE DIPPING NEEDLE.

The important discovery of the *Inclination*, or *Dip* of the Magnetic Needle was made about the year 1576, by ROBERT NORMAN, a Compass-maker, residing at Wapping, who in 1580 published a Pamphlet entitled, "The NEWE ATTRACTIVE, shewing the Nature, Propertie, and manifold Vertues of the LOADSTONE; with the Declination of the Needle, touched therewith, under the Plaine of the Horizon. Found out and discovered by Robert Norman." The sole credit of the discovery was awarded to him by Dr. Gilbert and Mr. William Burrows, contemporary writers on the subject of Magnetism. The "Newe Attractive" was dedicated to Mr. Burrows, and Dr. Gilbert speaks of the Author in the following terms: "This is that Robert Norman, that skilful Seaman, that ingenious Artificer, who first found out the Inclination of the Magnetick Needle." Mr. Bond also assures us, about a century after the invention, "That himself saw an Inclinatory Needle of one Dr. Merret's, which was made by this Robert Norman, A.D. 1578, and which he fitted up for the Doctor's use."



This curious pamphlet was reprinted in 1720 by Mr. William Whiston, and subjoined to a work of his own on the discovery of the Longitude and Latitude by the Inclinatory or Dipping Needle. The following extracts, comprehending the third and fourth Chapters of "the Newe Attractive," and containing the Author's account of the discovery, in which the style and orthography are correctly preserved, will no doubt be acceptable to our readers. In the illustrative engraving which accompanies the fourth chapter, our artist has given a perfect fac-simile of the rude cut contained in "the Newe Attractive:"—

CHAP. III.

By what meanes the rare and strange Declining of the Needle, from the plaine of the Horizon was first found.

Hauing made many and diuers compasses, and using alwaies to finish and end them before I touched the needle, I found continually, that after I had touched the yrons with the Stone, that presently the north point thereof would bend or *Decline* downwards under the Horizon in some quantitie: insomuch that to the Flie of the Compasse, which before was made equall, I was still constrained to put some small peece of waxe in the South part thereof, to counterpoise this *Declining*, and to make it equall againe.

Which effect having many times passed my hands without any great regard thereunto, as ignorant of any such propertie in the Stone, and not before hauing heard nor read of any such matter: It chaunced at length that there came to my hands an Instrument to bee made, with a Needle of sixe inches long, which needle after I had pollished, cut off at Just length, and made it to stand levell upon the pinne, so that nothing rested but onely the touching of it with the stone: when I had touched the same, presently the north part thereof *Declined* downe in such sort, that beeing constrayned to cut away some of that part, to make it equall againe, in the end I cut it too short, and so spoyled the needle wherein I had taken so much paynes.

Hereby beeing stroken in some choller, I applyed my self to seeke further into this effect, and making certayne learned and expert men (my friends) acquainted in this matter, they advised me to frame some Instrument, to make some exact tryal, how much the needle touched with the stone would *Decline*, or what greatest Angle it would make with the plaine of the Horizon. Whereupon I made diligent proofes: the manner whereof is shewed in the Chapter following.

CHAP. IV.

How to finde the greatest Declining of the Needle under the Horizon.

Take a small Needle of Steele wier, of five or sixe inches long, the smaller and the finer mettall the better, and in the middle thereof (crosse the same) by the best meanes you can, fixe as it were a small Axeltree of yron or brasse, of an inch long, or thereabout, and make the ends thereof very sharpe, whereupon the Needle may hang levell, and play at his pleasure.

Then provide a round plaine Instrument like an Astrolobe, to be divided exactly into 360 partes, whose diameter must be the length of the Needle, or thereabout, and the same instrument to bee placed uppon a foot of convenient height, with a plumme line to sette it perpendicular.

Then in the Center of the same Instrument, place a peece of Glasse hollowed, and against the same Center uppon some place of Brasse that may be fixed upon the foot of the Instrument, fit another peece of Glasse, in such sorte that the sharpe endes of the Axeltree beeing borne in these two Glasses, the Needle may play freely at his pleasure, according to the standing of the Instrument.

And the Needle must be so perfected, that it may hang upon his Axeltree both ends levell with the Horizon, or beeing turned, may stand and remaine at any place that it shall be sette: which being done, touch the saide Needle with the *Magnes* stone, and set the Instrument perpendicular by the plumme line, and turne the edge of the Instrument South and North, so as the Needle may stand duley according to the *Variation* of the place: which *Variation* the Needle of his owne propertie would shew, were it not that he is constrained to the contrarie by the Axeltree.

Then shall you see the *Declination* of the North point of the touched Needle, which for this Citie of *London*, I finde by exact observation to be about 71 degrees 50 minutes. The forme of the Instrument heere described with the manner of the declination, I have heere placed that it may be the easier conceived.

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THE CRYSTAL PALACE EXHIBITION.

Messrs. Siemens's Exhibits.

It may be that some of the best exhibits have been relegated to a late period for description, but this is a misfortune that could not well be avoided. Messrs. Siemens's exhibit was of such a varied description that we shall not attempt to deal with it in one article. It included dynamo-machines, arc, and incandescent lamps, materials used in submarine and aërial telegraphy, instruments of precision, &c., all of which were constructed in a first-class manner, in accordance with the established reputation of the house.

One of the most prominent features in the exhibition was the chandelier or electrolier for arc lights exhibited by this firm. We believe this elaborate and elegantly designed appendage was constructed by the Paris branch of the house specially for the Paris Electrical Exhibition, where, meeting the view of the visitors immediately after entering the Palais de l'Industrie, it attracted a considerable amount of attention. Our illustration (Fig. 1) of this chandelier will give a fair idea of the workmanship and design.

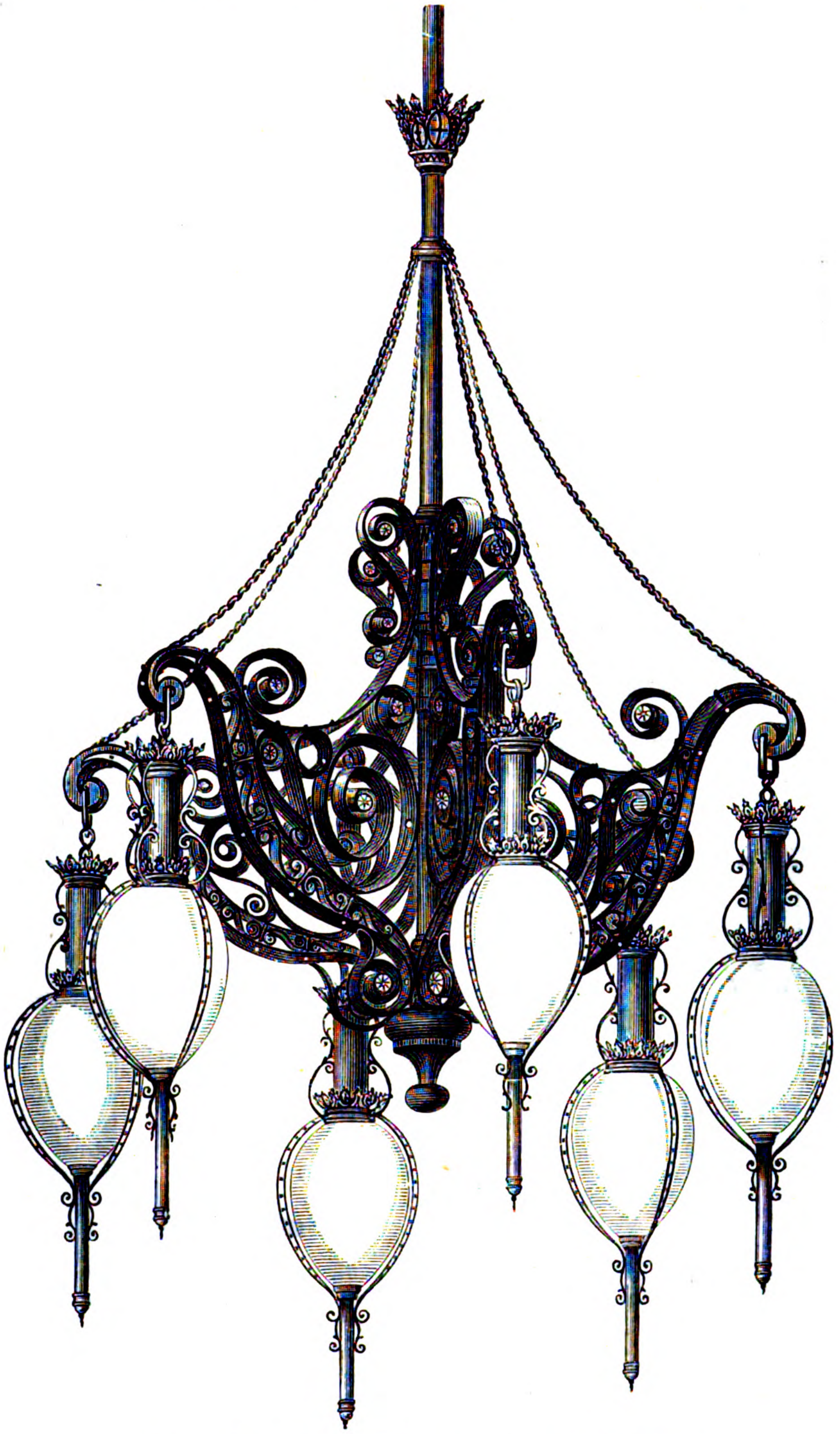

Fig. 1.—Chandelier supporting Siemens' Differential Lamps.

The following account of electric light apparatus is principally taken from a pamphlet just issued by this firm, a copy of which has been sent to us. The apparatus employed for the production of electric light consists of (1) the motor, (2) the electrical machine, (3) the leading wires, (4) the lamps, and (5) accessories.

We shall rather reverse the order in which they are here given, and proceed to describe the lamps first, as they seem

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to be more in keeping with the chandelier illustrated above. The machines, &c., we shall deal with in a future article.

Messrs. Siemens make two classes of arc lamps, the one to burn with continuous current machines, the other with alternate current machines. The continuous current lamp is named by them the "Pendulum" lamp; the one which burns

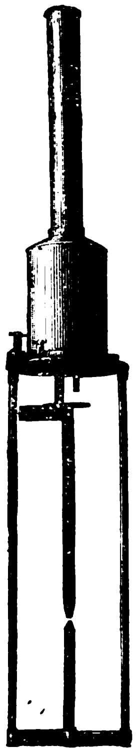

FIG. .—Siemens' Inverted Pendulum Lamp.

with alternate currents they call the "Differential" lamp. The pattern most extensively used is the pendulum lamp, in

FIG. 3.—Street Lamp on Gas Column.

which the length of the arc is regulated without the use of clockwork. They are manufactured in three patterns—the large upright lamp, the small ditto, and the inverted lamp. The latter is shown in Fig. 2.

In these lamps the carbon connected to the positive terminal of the machine burns away twice as fast as the other carbon. The arc, therefore, gradually descends whilst burning. In cases, however, where it is required to keep the arc at the same point of the lamp, a Siemens abutment pole is used for that purpose.

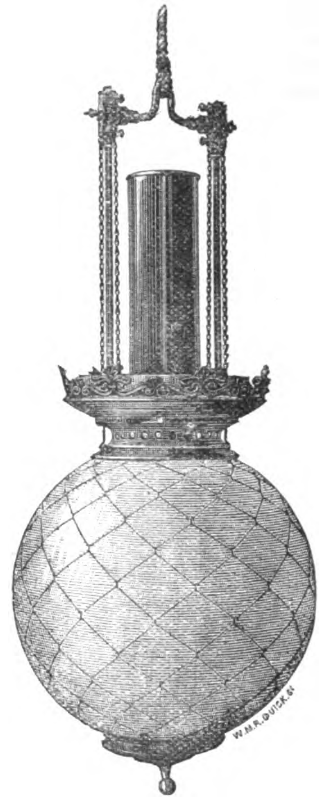

FIG. 4.—Hanging Lamp, with Glazed Globe.

The alternate current, or differential lamp, is also made with a descending or stationary arc. In this lamp both car-

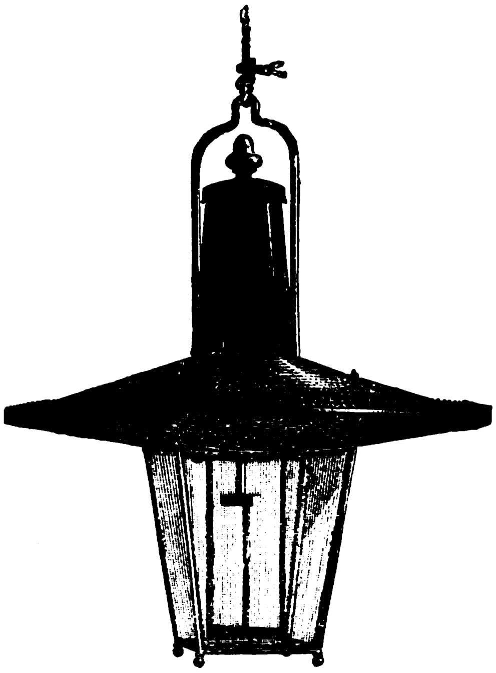

FIG. 5.—Lantern, with Reflector.

bons are consumed at the same rate and burn to a point. In this case the upper carbon is supported by a horizontal bar, which is jointed on to a vertical rod, working parallel with the upper carbon. The ends of this rod are centred into two bobbins, the upper one covered with a thick coil of wire, the lower one with a thin coil, both of which are in the

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circuit. This rod is of twice the length of each bobbin, and its ends in the normal position are at the centres of the bobbins. The attraction of the upper or thick coil on the iron rod tends to draw the upper carbon upwards by means of the horizontal bar connecting the iron rod and carbon. This lengthens the arc and diminishes the current, consequently the attraction of the bobbin is weakened, and the arc again diminished. All lamps are provided with a short-circuiting switch, by means of which the current is diverted from the lamp during the operation of replacing the carbons.

Messrs. Siemens have devised a great variety of lanterns and reflectors to suit the numerous localities and surroundings in which they have had to erect lamps from time to time. Fig. 3 shows one of their lamps fitted to an ordinary gas column. Fig. 4 is a hanging lantern, fitted with glazed globe to modify the intense brightness

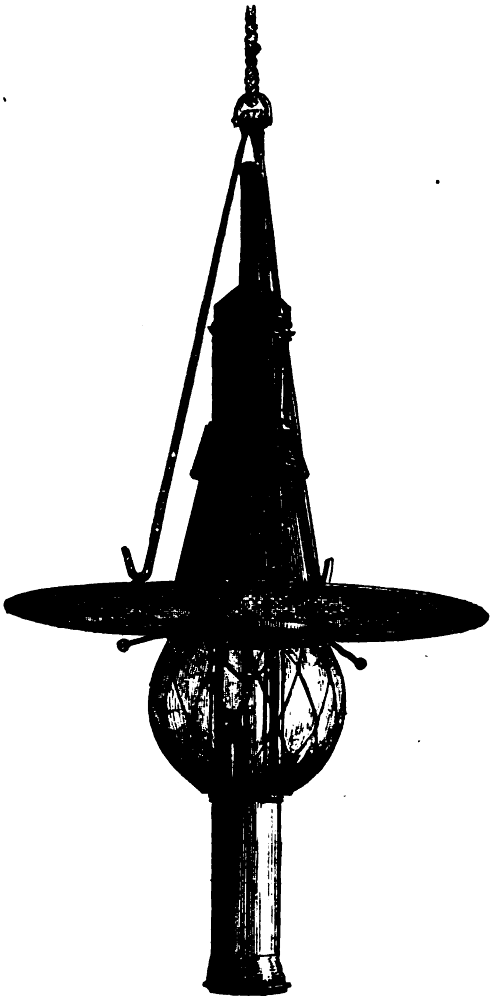

Fig. 6.—Lamp used to Light the Albert Dock

of the arc. This class of lantern was used by Messrs. Siemens for the British Museum Reading Room, and seemed to answer its purpose well. Fig. 5 is a type of lantern with large reflector, whose duty it is to intercept the upward rays, and to throw them down on the street or ground beneath. Fig. 6 illustrates the class of lantern adopted by Messrs. Siemens for lighting the Royal Albert Dock, the lanterns being strongly made and fitted with powerful reflectors.

These lanterns were suspended from latticed iron posts about 80 feet high, and calculated to illuminate an area of nearly nine acres each.

Numerous other kinds of lamps were shown by the firm, including examples of those used by them in carrying out their contract for lighting the city last year.

(TO BE CONTINUED.)

BRITISH ASSOCIATION.

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SCIENCE SECTION.

BY RIGHT HON. LORD RAYLEIGH, M.A., F.R.S., F.R.A.S.

In common with some of my predecessors in this chair, I recognise that probably the most useful form which a presidential address could take, would be a summary of the progress of physics, or of some important branch of physics, during recent years. But the difficulties of such a task are considerable, and I do not feel myself equal to grappling with them. The few remarks which I have to offer are of a general, I fear it may be thought of a commonplace, character. All I can hope is that they may have the effect of leading us into a frame of mind suitable for the work that lies before us.

The diversity of the subjects which come under our notice in this section, as well as of the methods by which alone they can be adequately dealt with, although a sign of the importance of our work, is a source of considerable difficulty in the conduct of it. From the almost inevitable specialisation of modern science it has come about that much that is familiar to one member of our section is unintelligible to another, and that details whose importance is obvious to the one fail altogether to rouse any interest in the mind of the other. I must appeal to the authors of papers to bear this difficulty in mind, and to confine within moderate limits their discussion of points of less general interest.

Even within the limits of those departments whose foundation is evidently experimental there is room, and indeed necessity, for great variety of treatment. One class of investigators relies mainly upon reiterated appeals to experiment to resolve the questions which appear still to be open, while another prefers, with Thomas Young, to base its decisions as far as possible upon deductions from experiments already made by others. It is scarcely necessary to say that in the present state of science both methods are indispensable. Even where we may fairly suppose that the fundamental principles are well established careful and often troublesome work is necessary to determine with accuracy the constants which enter into the expression of natural laws. In many cases the accuracy desirable, even from a practical point of view, is hard to attain. In many others, where the interest is mainly theoretical, we cannot afford to neglect the confirmations which our views may derive from the comparison of measurements made in different fields and in face of different experimental difficulties. Examples of the interdependence of measurements apparently distinct will occur to every physicist. I may mention the absolute determinations of electrical resistance, and of the amounts of heat developed from electrical and mechanical work, any two of which involve also the third, and the relation of the velocity of sound to the mechanical and thermal properties of air.

Where a measurement is isolated, and not likely to lead to the solution of any open question, it is doubtless possible to spend upon it time and attention that might with advantage be otherwise bestowed. In such a case we may properly be satisfied for a time with work of a less severe and accurate character, knowing that with the progress of knowledge the way is sure to be smoothed both by a better appreciation of the difficulties involved, and by the invention of improved experimental appliances. I hope I shall not be misunderstood as underrating the importance of great accuracy in its proper place if I express the opinion that the desire for it has sometimes had a prejudicial effect. In cases where a rough result would have sufficed for all immediate purposes, no measurement at all has been attempted, because the circumstances rendered it unlikely that a high standard of precision could be attained. Whether our aim be more or less ambitious, it is important to recognise the limitations to which our methods are necessarily subject, and as far as possible to estimate the extent to which our results are uncertain. The comparison of estimates of uncertainty made before and after the execution of a set of measurements may sometimes be humiliating, but it is always instructive.

Even when our results show no greater discrepancies than

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we were originally prepared for, it is well to err on the side of modesty in estimating their trustworthiness. The history of science teaches only too plainly the lesson that no single method is absolutely to be relied upon, that sources of error lurk where they are least expected, and that they may escape the notice of the most experienced and conscientious worker. It is only by the concurrence of evidence of various kinds, and from various sources, that practical certainty may at last be attained, and complete confidence justified. Perhaps I may be allowed to illustrate my meaning by reference to a subject which has engaged a good deal of my attention for the last two years—the absolute measurement of electrical resistance. The unit commonly employed in this country is founded upon experiments made about twenty years ago by a distinguished committee of this Association, and was intended to represent an absolute resistance of 10^9. C.G.S., *i.e.*, one ohm. The method employed by the committee at the recommendation of Sir W. Thomson (it had been originally proposed by Weber) consisted in observing the deflection from the magnetic meridian of a needle suspended at the centre of a coil of insulated wire, which formed a closed circuit, and was made to revolve with uniform and known speed about a vertical axis. From the speed and deflection in combination with the mean radius of the coil and the number of its turns, the absolute resistance of the coil, and thence of any other standard, can be determined.

About ten years later Kohlrausch attacked the problem by another method, which it would take too long to explain, and arrived at the result that the B.A. unit was equal to 1·02 ohms—about 2 per cent. too large. Rowland, in America, by a comparison between the steady battery current flowing in a primary coil with the transient current developed in a secondary coil when the primary current is reversed, found that the B.A. unit was ·991 ohm. Lorentz, using a different method again, found ·980, while H. Weber, from distinct experiment, arrived at the conclusion that the B.A. unit was correct. It will be seen that the results obtained by these highly competent observers range over about 4 per cent. Two new determinations have lately been made in the Cavendish laboratory at Cambridge, one by myself with the method of the revolving coil, and another by Mr. Glazebrook, who used a modification of the method followed by Rowland, with the result that the B.A. unit is ·986 ohm. I am now engaged upon a third determination, using a method which is a modification of that of Lorentz.

In another important part of the field of experimental science, where the subject matter is ill understood, and the work is qualitative rather that quantitative, success depends more directly upon sagacity and genius. It must be admitted that much labour spent in this kind of work is ill-directed. Bulky records of crude and uninterpreted observations are not science, nor even in many cases the raw material out of which science will be constructed. The door of experiment stands always open; and when the question is ripe, and the man is found, he will nine times out of ten find it necessary to go through the work again. Observations made by the way, and under unfavourable conditions, may often give rise to valuable suggestions, but these must be tested by experiment, in which the conditions are simplified to the utmost, before they can lay claim to acceptance.

When an unexpected effect is observed the question will arise whether or not an explanation can be found upon admitted principles. Sometimes the answer can be quickly given; but more often it will happen that an assertion of what *ought* to have been expected can only be made as the result of an elaborate discussion of the circumstances of the case, and this discussion must generally be mathematical in its spirit, if not in its form. In repeating, at the beginning of the century, the well-known experiment of the inaudibility of a bell rung in vacuo, Leslie made the interesting observation that the presence of hydrogen was inimical to the production of sound, so that not merely was the sound less in hydrogen than in air of equal pressure, but that the actual addition of hydrogen to rarefied air caused a diminution in the intensity of sound. How is this remarkable fact to be explained? Does it prove that, as Herschel was inclined to think, a mixture of gases of widely different densities differs in its acoustical properties from a single gas? These questions could scarcely be answered satisfactorily but by a mathematical investigation of the process by which vibrations are communicated from a vibrating solid body to the surrounding gas. Such an investigation, founded exclusively upon principles well established before the date of Leslie's observation, was undertaken years afterwards by Stokes, who proved that what Leslie observed was exactly what ought to have been expected. The addition of hydrogen to attenuated air increases the wave-length of vibrations of given pitch, and consequently the facility with which the gas can pass round the edge of the bell from the advancing to the retreating face, and thus escape those rarefactions and condensations which are essential to the formation of a complete sound wave. There remains no reason for supposing that the phenomenon depends upon any other elements than the density and pressure of the gaseous atmosphere, and a direct trial, *e.g.*, a comparison between air and a mixture of carbonic anhydride and hydrogen of like density, is almost superfluous.

Examples such as this, which might be multiplied *ad libitum*, show how difficult it often is for an experimenter rightly to interpret his results without the aid of mathematics. It is eminently desirable that the experimenter himself should be in a position to make the calculations to which his work gives occasion, and from which in return he would often receive valuable hints for further experiment. I should like to see a course of mathematical instruction arranged with especial reference to physics, within which those whose bent was plainly towards experiment might, more or less completely, confine themselves. Probably a year spent judiciously on such a course would do more to qualify the student for actual work than two or three years of the usual mathematical curriculum. On the other side, it must be remembered that the human mind is limited, and that few can carry the weight of a complete mathematical armament without some repression of their energies in other directions. With many of us difficulty of remembering, if not want of time for acquiring, would impose an early limit. Here, as elsewhere, the natural advantages of a division of labour will assert themselves. Innate dexterity and facility in contrivance, backed by unflinching perseverance, may often conduct to successful discovery or invention a man who has little taste for speculation; and, on the other hand, the mathematician, endowed with genius and insight, may find a sufficient field for his energies in interpreting and systematising the work of others.

The different habits of mind of the two schools of physicists sometimes lead them to the adoption of antagonistic views on doubtful and difficult questions. The tendency of the purely experimental school is to rely almost exclusively upon direct evidence, even when it is obviously imperfect, and to disregard arguments which they stigmatise as theoretical. The tendency of the mathematician is to overrate the solidity of his theoretical structures, and to forget the narrowness of the experimental foundation upon which many of them rest.

By direct observation, one of the most experienced and successful experimenters of the last generation convinced himself that light of definite refrangibility was capable of further analysis by absorption. It has happened to myself, in the course of measurements of the absorbing power of various media for the different rays of the spectrum, to come across appearances at first sight strongly confirmatory of Brewster's views, and I can, therefore, understand the persistency with which he retained his opinion. But the possibility of further analysis of light of definite refrangibility (except by polarisation) is almost irreconcilable with the wave theory, which on the strongest grounds had been already accepted by most of Brewster's contemporaries; and in consequence his results, though urgently pressed, failed to convince the scientific world. Further experiment has fully justified this scepticism, and in the hands of Airy, Helmholt, and others, has shown that the phenomena by which Brewster was misled can be explained by the unrecognised intrusion of diffused light. The anomalies disappear when sufficient precaution is taken that the refrangibility of the light observed shall really be definite.

On similar grounds undulationists early arrived at the con

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viction that physically light and invisible radiant heat are both vibrations of the same kind, differing merely in wave-length; but this view appears to have been accepted slowly, and almost reluctantly, by the experimental school.

When the facts which appear to conflict with theory are well defined, and lend themselves easily to experiment and repetition, there ought to be no great delay in arriving at a judgment. Either the theory is upset, or the observations, if not altogether faulty, are found susceptible of another interpretation. The difficulty is greatest when the necessary conditions are uncertain, and their fulfilment rare and uncontrollable. In many such cases an attitude of reserve, in expectation of further evidence, is the only wise one. Premature judgments err perhaps as much on one side as on the other. Certainly in the past many extraordinary observations have met with an excessive incredulity. I may instance the fire-balls which sometimes occur during violent thunder-storms. When the telephone was first invented, the early reports of its performances were discredited by many on quite insufficient grounds.

It would be interesting, but too difficult and delicate a task, to ennumerate and examine the various important questions which remain still undecided from the opposition of direct and indirect evidence. Merely as illustrations I will mention one or two in which I happen to have been interested. It has been sought to remedy the inconvenience caused by excessive reverberation of sound in cathedrals and other large unfurnished buildings by stretching wires overhead from one wall to another. In some cases no difference has been perceived, but in others it is thought that advantage has been gained. From a theoretical point of view it is difficult to believe that the wires could be of service. It is known that the vibrations of a wire do not communicate themselves in any appreciable degree directly to the air, but require the intervention of a sounding-board, from which we may infer that vibrations in the air would not readily communicate themselves to stretched wires. It seems more likely that the advantage supposed to have been gained in a few cases is imaginary than that the wires should really have played the part attributed to them.

The other subject on which, though with diffidence, I should like to make a remark or two, is that of Prout's law, according to which the atomic weights of the elements, or at any rate of many of them, stand in simple relation to that of hydrogen. Some chemists have reprobated strongly the importation of *à priori* views into the consideration of the question, and maintain that the only numbers worthy of recognition are the immediate results of experiment. Others more impressed by the argument that the close approximations to simple numbers cannot be merely fortuitous, and more alive to the inevitable imperfections of our measurements, consider that the experimental evidence against the simple numbers is of a very slender character, balanced, if not outweighed, by the *à priori* argument in favour of simplicity. The subject is eminently one for further experiment; and as it is now engaging the attention of chemists, we may look forward to the settlement of the question by the present generation. The time has perhaps come when a redetermination of the densities of the principal gases may be desirable—an undertaking for which I have made some preparations.

If there is any truth in views that I have been endeavouring to impress, our meetings in this section are amply justified. If the progress of science demands the comparison of evidence drawn from different sources, and fully appreciated only by minds of different order, what may we not gain from the opportunities here given for public discussion, and, perhaps more valuable still, private interchange of opinion? Let us endeavour, one and all, to turn them to the best account.

Western and Brazilian Telegraph Company.—The traffic receipts of this company for the week ending 18th August, 1882, were £1,752, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

ELECTRIC LIGHTING AT SOUTH KENSINGTON.

The report just published by Lieut.-Colonel Festing, R.E., the assistant-director specially entrusted with the charge of the museum buildings, South Kensington, including lighting, heating, ventilation, &c., states that during the past year the consumption of gas at South Kensington shows a decrease as compared with 1880 of 3,151,200ft., costing at present prices £498 18s. 10d., and as compared with 1879 of 5,381,300ft., costing £852. This decrease is attributable to the extension of the use of the electric light. Since May a second 16-light Brush machine has been at work, and the Raphael and Sheepshanks rooms are now lighted, as well as the Lord President's court. An alteration of the method of hanging the lamps in the latter has been carried out on one side, and, being found satisfactory, is now being applied to the other side; at the same time it is found advisable to raise the lamps a little, so as to get them more above the level of the eye of people in the galleries, and to add two lamps to each side. The disposition of the lamps will therefore be as follows:—Lord President's court, 20 lamps; Sheepshanks Galleries, six lamps; Raphael Gallery six lamps. Total, 32 lamps. The expectation of an economy in working if two machines were driven by the engine has been amply borne out. With the two machines and 32 lamps the indicated horse-power of the engine is 38, and the consumption of coal per hour of work, a fraction under 112lb., as against 81lb. last year, when there were only 16 lamps. There has been also considerable economy in wages, as the only addition to this head has been for the trimming the additional number of lamps. Up to the end of the year the 32 lamps had been at work for nearly six months, or 346 hours of lighting. The cost of working has been as follows:—Carbons per hour, 2s. (per lamp per hour, ·76d.); coal per hour, $10\frac{3}{4}$d. (per lamp per hour, ·33d.); oil per hour, $5\frac{1}{2}$d. (per lamp per hour, ·17d.); wages, per hour, 2s. 6d. (per lamp per hour, ·94d.)—making a total per hour of 5s. $10\frac{1}{4}$d. (per lamp per hour, 2·2d.)

The consumption of gas in the same space would have been 8,600 cubic feet per hour, costing at the present price £1 7s. $2\frac{3}{4}$d. The saving in working expenses is, therefore, £1 1s. $4\frac{1}{2}$d. an hour, or at the rate of nearly £750 a year, or more than £23 per lamp per year.

It is interesting to compare with the results of working two machines with a steam engine here, those of working one machine and fourteen lamps with a twelve horse-power gas engine at Jermyn-street. The lamps there are lighted for a little over 400 hours in the year, and from one year's experience the hourly cost of the light is found to be as follows:—Carbons, $10\frac{1}{2}$d.; gas for engine, 340ft. at 3s. 11d., 1s. 4d.; oil, &c., 4d.; wages, 1s. 6d.—total, 4s. $0\frac{1}{2}$d.

This gives a cost of $3\frac{1}{2}$d. per lamp per hour. Of the 14 lamps, three are in places not hitherto lighted in the evening. The consumption of gas in the Museum was at the rate of 2,100ft., costing 8s. 3d. per hour, the gas being of the quality known as "20 candles." The cost of 11 electric lamps representing this gas is 3s. 2d. per hour. The outlay on the installation, including motive power, machines and lamps, and a rather more ornamental treatment of the latter than has been attempted so far, may be estimated at £70 per lamp, on which the annual saving on working expenses as determined at South Kensington will represent 33 per cent. This, however, necessarily depends upon the price of gas and the quantity of gas which each lamp replaces, and it is not possible always to arrange the lamps so that each may replace its full equivalent of gas. For some months the temporary reading room of the Art Library has been lighted by Lane-Fox incandescent lights with very satisfactory results. The room is 50ft. by 20, and 18ft. high. Twelve Lane-Fox lamps replaced 15 Sugg's argand gas burners. The current is supplied by a "Brush" machine driven by the gas-engine. This small experiment does not give much information as to the cost of this system of lighting, as the lights take only a small portion of the power of the machine. There seems to be little doubt, however, that the working expenses of lighting with incandescent lamps is about the same as the cost of gas burnt in the best argand burners. It is evident that no fumes

can be produced by an incandescent lamp, as the heated carbon filament is enclosed in a glass globe, which is hermetically sealed. For the same reason the only way in which heat is given off is by radiation. From a somewhat rough test with a thermopile it is found that the quantity of radiant heat given off by a Lane-Fox lamp is, for equal light, in the proportion of about one-sixth that emitted from a good argand gas burner (Sugg's "London"). It should be borne in mind that the radiant is but a small portion of the whole heat produced by a gas flame, the chief part of which passes away in the heated fumes. It is possible to remove these fumes from the room by pipes; but even if this be perfectly accomplished the incandescent electric light will have the advantage of giving only one-sixth part of the heat. The difficulty of applying these pipes, however, is often very great, and they are necessarily expensive and ugly. The light of these lamps is almost as yellow as that of gas, which renders it unsuitable for cases where colour has to be carefully studied, and it was not found to answer for the life room in the art schools when a trial was made of it. The Brush (arc) light has also been tried, and as to colour was found very satisfactory. The heat given out is, in proportion to the light, considerably less than in the case of incandescent lights; but the unsteadiness was at times very great. It is hoped, however, to be able to correct this defect to some extent in some lamps which will shortly be put in the schools.

CORRESPONDENCE.

WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In Mr. Harbord's letter, p. 184, he charged me with having "*said* that there is no such thing as magnetic repulsion." I pointed out that I had never written as above, and asked for proof. In Mr. Harbord's last letter to you, page 249, he gives as proof a partial quotation from my letter to you of 3rd June, page 62. The full passage is as follows:—"In the published document which I sent to Faraday, Arago, and others in 1839, I stated that, from the experiments then made, I had reason to believe that *static induction* had no existence in fact, that the phenomena of electricity were all produced by one electricity, and that it was not like the one electricity of Franklin, who imagined that electricity and matter did each possess a repellant power within themselves, whereas I maintain that electricity has no repellant power. All the phenomena supposed to be from repulsion arise from attraction." From the foregoing it is manifest that I wrote only about "static electricity," and there is no mention whatever about magnetism in my letter. It is, therefore, manifest that Mr. H. confounds magnetism with "static electricity." That which men have called "static repulsion," if it has any existence at all, is a repulsion of electricity between its own particles; whereas magnetic repulsion arises from the result of a compound action of common matter and of electric matter. To confound magnetism with "static electricity" is a blunder of Mr. H.'s. I believe firmly in magnetic repulsion, while I maintain that there is no such thing as that which men have called "static repulsion."

In Mr. Harbord's letter, p. 184, he alleged that my discovery regarding the action of a Leyden jar was not new. I asked for further explanation on this point, and he has given the following quotation from a book by Sir Wm. Snow Harris:—"A succession of sparks will be observed to pass into the jar; these will become gradually weaker when the jar is fully charged." The phenomenon here noted must have been observed by every careful experimenter since the time the Leyden jar was discovered. My discoveries relate to a very different matter. If Mr. H. had read correctly or understood correctly what he did read when he quoted from my letter at page 155 he would have seen that that which he has written on this point is a blunder on his part. To save troubling you with a long paragraph I quote merely the end of it:—"I gave experimental proof that the glass of the Leyden jar did conduct electricity (through it) up to the moment that the jar became fully charged internally with electricity, and then the glass ceased to conduct the electricity, a discovery which is new in the science of electricity, and gives us the means of knowing the true theory of the Leyden jar." That which Sir W. Snow Harris wrote about was the inlet of electricity to the interior of a Leyden jar, whereas my discovery relates to the passage of electricity through the glass of the Leyden jar, and to the fact that as the potential of the electricity increases within the jar, the electricity passing through the glass of the jar diminishes in quantity, and thereby making known that there is a contracting or attracting power between the particles of electricity, which is a totally different subject from that referred to by Mr. H. It is from confounding the two subjects that Mr. H. asserted that my discovery was not new.—Yours, &c., JAMES JOHNSTONE.

Experiment Rooms, 1, James-square,
Edinburgh, July 31, 1882.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Although Dr. Shettle has failed to reply to the objections I stated in your columns to his manner of defending Faraday's theory of two electric forces, he has in his letter to you, page 327, paragraph 27, written as follows:—"In proof of there being one current (of electricity) or force moving in one direction only, great stress has been laid upon the fact that the flame of a candle (of coal gas) when exposed to a discharge of electrical force is bent in the direction which the discharge takes, and the behaviour of the flame under such conditions gives *primâ facie* evidence in favour of the theory. But when we closely investigate these phenomena, and subject the force to the laws of motion, so far as stress or action and reaction are concerned, we find that the bent position has been given to the flame by the direction of the action which is the *primary force*. It is then, while in the bent position, traversed by the force of reaction, which being equal and opposed to the action, also tends to maintain the bent direction of the flame." The introductory part of the foregoing paragraph is a declaration that the object of the paragraph is to counteract the proof I have given that a flame bent by a current of electricity indicates the direction in which the current is moving, and helps to prove that there is only one electricity. After making the introductory admission that a flame bent by an electric current does indicate the direction in which that current of electricity moves, Dr. Shettle proceeds to assert that there is what he calls a "force of reaction which . . . also tends to maintain the bent direction of the flame." Now, does Dr. Shettle mean to assert that that which he calls the "force of reaction" is an electric current which arises within the flame? If this is his meaning, then his assertion is directly opposed to the results obtained by the experiments of Herren Elster and Geitel, recently published. After describing one of their experiments, it is added, "from this experiment, which was confirmed in a variety of ways, it appears that *a flame is not in itself a source of electrification at all.*" Hence Dr. Shettle's assumed "force of re-action" cannot be a counter current of electricity arising within the flame. If he means that the force of reaction is something else than a counter current of electricity, then he has failed to show that there are two electric forces involved or existing when a flame is bent by a current of electricity.—Yours, &c., JAMES JOHNSTONE.

Experiment Rooms, 1, James-square,
Edinburgh, Aug. 21, 1882.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A copy of your paper of the 19th inst. having chanced to fall into my hands I was struck with the above heading, and with the letter of your correspondent, Dr. Shettle. I do not think that he makes an obscure subject

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less obscure by the process which he adopts. Nor am I sure that I shall succeed by adopting a very different process. But let me make an attempt. I have to say that, in the first place, there must be what is called a *science of force*, not yet apprehended; and that, in the second place, it can never be acquired by *appealing simply to matter* as such.

That there is a medium underlying all matter has been tolerably well ascertained. It is usually spoken of as "highly elastic," "of extreme tenuity," or "incapable of exhaustion," as "in itself structureless," as "non-atomic," and so forth. Is there not reason to suppose that this medium plays an important part in all the forces which so variously display themselves in the natural world? To my mind this medium (call it ether) is not strictly matter, yet stands at the basis of all matter. It is substance, and so is matter; but the distinction betwixt the two is that matter is the expression of substance under *limitation* as to quantity and quality (hence atom). Ether, as spirit, is the substance out of which that expression is derived, and is under *non-limitation* as to quantity and quality. My belief is that without the latter no force whatever can have its manifestation in nature.

Ether as a medium must have some intrinsic attribute of its own. *On the side of quality*, I believe it to be the basis of all created quality; and hence there must be an affinity betwixt the atoms of matter, as we know to be the case; and these atoms accordingly have their laws of combination. *On the side of energy*, I believe its intrinsic, essential, and inalienable attribute is power, that is the capacity of force. With these two (matter and ether) we can account for the manifestation of force, *i.e.*, of momentum, as endlessly exhibited in the world.

Ether *per se* (if you can conceive this), *i.e.*, an endless medium of spirit, must be quiescent. In order to create momentum there must be some limiting ingredient interposing. The limiting ingredients are primarily atoms, and the relationship in which the atoms stand to one another gives the law of their combination. This combination is a manifestation of force. Out of this we obtain the law of causalty, that is the law in virtue of which force is manifested. It stands thus: Given the qualities of certain elements brought into that contiguity whereby they affect one another, and the relation in which they stand to each other, to find the phenomenon or resultant.

Over the whole realm of nature I believe this law of causality holds good. And what is it in point of fact? It is the *material qualities* initiating the force, and giving the character of the force according to the kind of ingredients assembled, and the relation to one another under which they are assembled, and the *sympathising ether* which supplies the precise energy demanded by the causal elements engaged. Thus must force invariably be graduated, as gentle or violent, according to the ingredients, while also it takes its force according to the relation of the ingredients, as the factors productive of every phenomenon.

Now, there are several grand forces in nature, such as gravitation, light, heat, electricity, magnetism, chemical affinity, &c. If I am asked what is Gravitation? I answer—*It is Ether* carrying the affinity which prevails betwixt the sun and the earth. If I am asked—What is Light? I answer—*It is Ether* carrying the luminosity which prevails in the sun to the earth, or from any lighted body, weakened as the square of the distance increases. If I am asked—What is Heat? I answer—*It is Ether* carrying the temperature which prevails in the sun to the earth, and is analogous in its operation to that of light. If I am asked—What is Electricity? I answer—*It is Ether* carrying the condition impressed upon a particular channel of communication throughout that channel, when it is excited by means of an irritant such as the ordinary battery employs. If I am asked what is Magnetism? I answer—*It is Ether*, in like manner carrying forth the behests of matter, under the polaric condition induced by electricity, which condition may become static. If I am asked what is Chemical Affinity? I answer—*It is Ether*, giving validity to the attractions or repulsions, as the case may be, of different qualities of matter brought into conjunction, and this according to the inherent relation in which one quality of matter stands affected by another in the same causal connection.

The *initiation* of force, then, belongs to matter; the *realisation* of force belongs to ether. Ether, then, is all-pervading, and endlessly takes on the characteristics of matter, however many and various, without confusion and without collision. We know that the same object in the skies will be reflected on ten thousand eyes, and, consequently, must be regarded as pervading the space within its circuit; but a thousand objects set up will, in like manner, be made to pervade the same intervening space. We know that the same telegraphic wire can be made to transmit a variety of messages at one and the same time—a thing which seems impossible under the law of mechanical colliding, had we nothing to refer to beyond an exclusively material medium. We know, moreover, that all the forces in nature may be operating within one and the same special circuit, but ether is equal to them all. It cannot be exhausted; its nature as the source of force is non-limitation. It opens up to us the wondrous resources which exist in what is called spirit as distinguished from matter.

It is obvious that much might be written on the theme which I have thus faintly sketched; but I forbear trespassing further on your space, and I shall feel obliged, for the sake of ventilating further an all-important subject, if you will give what I have written a place in your journal.—Yours, &c., GEORGE JAMIESON.

Old Aberdeen, 23rd August, 1882.

THE LAMP MANIA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The letter of Mr. Paget Higgs in your issue of 12th contains the views of a practical electrician and author, and merits the thoughtful attention of the public after the wild excitement and dangerous contagion of our recent electric mania.

Whatever may be justly urged against the right to the inventions of certain patented electrical apparatus, we must, nevertheless, be impressed with the admirable manner by which the whole process of coinage has been so financially and so egotistically utilised by what I apprehend are the copyists. Certainly the public has been spirited back to the age of Eastern fable, and we have, as in times long ago, our Aladdin's wonderful lamp again, yet in a different but quite as romantic a form. We are assured that the possessor of that identical lamp had only to rub it, when, presto! untold gold was placed instantly before him. Now we have many "wonderful lamps," which when rubbed by their original owners have brought immediately before their very surprised senses thousands of good gold pieces. But then there is this great difference between the lamp of Eastern fable and our modern electric—the magic of the former remained with its possessor wherever it might be, whilst the latter loses its charm the instant it is sold; in fact, bringing gold only once, and that to the patentee. But in any great modern inventions can you discover approximate examples at all between what were paid for them and those immense startling sums charged to public shareholders of electric companies for small, and in some cases doubtful parts of electric apparatus? Here, for instance, is a lamp, principally made up of a few small pieces of marble and two carbon sticks, appearing in the accounts of a public company at a cost of, say, £10,000. Another patent of singular origin obtains £15,000 for its fortunate patentee. In fact the appetite seems "to grow upon what it feeds," for in the published statement of proceedings one company, it would appear, has "secured" two or three of these costly gems for its fortunate proprietary; indeed, the company was asked some £40,000 for a patented luminary, but I read they "secured" it for a less sum as a great bargain.

But, underlying all this lavish expenditure, do you not observe a danger not only to the public interests, but to any struggling talent unsupported by the money of shareholders?

Some of these companies must try to earn a dividend for their shareholders; but how, heavily handicapped as they

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are, can they make much headway against gas at 2s. 10d. the 1,000 feet, the present price within the past few days in the leading commercial centres of Lancashire?

Their one-sided policy is manifestly foreshadowed in their public notices: to crush out all opposition under the plea of possessing the sole patent rights almost over the whole universe of some infallible system or another.

I have no doubt that, whatever may be the inventive faculties of our American friends in the creation of "rings" and similar pleasant contrivances in order to make much money, the English people will most strenuously oppose all attempts at a monopoly calculated to mulct them, moreover, for the costly prodigal extravagance of a few projectors of public electric companies.—Yours, &c., W.M.

Liverpool.

SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The following letter, which appeared in the issue of the first series of *The Electrician*, May 15th, 1863, is very interesting and very suggestive. It is very interesting because it leads one to ask, What is new in the Faure battery, and suggestive as to the ease with which patents are granted. Here is the letter:—

"Sir: According to the following description of secondary currents it seems possible that a secondary battery could be formed by sheets of canvas (or any other absorbent) material, if they be separated by sheets of gutta percha, and it would appear to carry out that which I have observed with the canvas which separates the sheets of lead in my secondary battery, for I find that if the plates and canvas expose a large surface no more power is gained by a given primary battery than if the surface were one-third less, so that I think the canvas becomes polarised positively, while the lead in contact with the copper of the primary becomes polarised negatively by the formation of peroxide, and this may account for the variable effects of the secondary battery. And I find that much better effects are produced if the leads are separated only by the solution in which they are placed, taking care they are not in contact, so that this would serve to corroborate the enclosed experiments.

"Will you be kind enough to say whether I could use the current from my induction coil (which is all in one direction) for the production of a secondary battery.—Yours, &c., J. Cook." —Yours, &c., X.

THE SCOTTISH BRUSH ELECTRIC LIGHT COMPANY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: There is a printer's error in your otherwise admirable report of what I said at the meeting of the Scotch Brush Electric Light Company that I should be glad to have rectified, as it somewhat alters the sense of that which follows.

The error is in the 10th line from bottom of page 33. It reads: "We have not sole concessions" should be "we have not sold concessions."—Yours, &c., W. Ladd.

Beak-street, Regent-street, August 19, 1882.

THE BINKO ELECTRIC RAILWAY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In the notice of a small pamphlet on the electric railway at the Crystal Palace in your issue of the 19th inst., I see you have quoted a paragraph which is inaccurate and liable to mislead. I refer to the passage:—"The station and offices are lighted by incandescent lamps, the engine which works the electric locomotive being also used for this purpose." The lighting of the station is a portion of Mr. André's exhibit, and the current is supplied from a "B" Gramme machine driven by the engine in the André driving station near the Bear Pit. As the engine driving the railway is *at present* only run intermittently, it would scarcely do for lighting the station. As I am responsible for Mr. André's entire exhibit, I can speak with certainty on the above point, and I trust you will find space for this slight correction.—Yours, &c., A. W. Brewtnall.

Streatham, August 23, 1882.

LIGHT FOR BICYCLE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I want an electric or lime light for my bicycle. If you or any of your correspondents can tell me whether there are such, and where they can be obtained, I should be greatly obliged.—Yours, &c., Bicycle.

117 and 119, Princess-street, Manchester.

*** Owing to the pressure on our space a great deal of matter has been crowded out of our columns this week, including a letter from Mr. Moseley on "Fire Risks from Electric Lighting."

NATIONAL TELEPHONE COMPANY (LIMITED).

The second annual general meeting of the shareholders of this Company was held on the 18th inst. at the offices, Queen Victoria-street, under the presidency of Colonel R. Raynsford Jackson.

The Secretary (Mr. W. B. Campbell) having read the notice convening the meeting,

The Chairman said: Gentlemen—I have to move—"That the report of the directors be accepted and confirmed by the shareholders." It is not my intention to dwell at any great length upon the position and prospects of the Company. They are, I think, sufficiently indicated in the balance-sheet and in the report. You will see that the Company's income for last year, or rather its revenue to the end of last year, had reached within a small fraction of £27,000, and that the profits for the year were £4,217 13s. 2d., which has enabled the directors to declare a dividend upon the preference shares of 6 per cent. and to carry forward a balance of £144 9s. 8d. One feature in the position of the Company which I think will be regarded as favourable is that we carry forward £15,643 5s. 5d. towards the gross revenue of the current year. The Company's business is divided into two kinds. There is the private wire business, which is entirely independent of the control of the Post Office, and for which we do not require the Postmaster-General's license. That business is steadily increasing, and I have no doubt that in the current and future years it will receive a very large development. For the exchange business we require the Postmaster-General's license, and it has been the policy of the Postmaster-General, up to recently, not to grant licenses to more than one company in one town. I do not mean to say that there has been no exception to that rule, because in Dundee two existing telephone companies were granted licenses, but, as a general rule, the Postmaster-General laid it down as his policy that there should not be rival telephone companies in one town. The Postmaster-General has, however, resolved to alter that policy, and to allow responsible parties applying for licenses to the Department to enter into rivalry with each other for the telephone business—for the exchange, which is a branch of the telephone business. This Company is under no apprehension whatever as to the consequences of the competition which may arise from the decision I have just mentioned of the Postmaster-General. In the first place, the Company's business is based, to a certain extent, upon the exclusive licenses it holds from the United Telephone Company to use its telephones, and act under its patents; and as the United Telephone Company has, with great spirit, defended its patents in the courts, it has placed itself in such a position that it is practically in legal possession of the master patents which control the telephone business. The Postmaster-General's license will, therefore, not be of very great value to any rival, because if a company desiring to enter into the exchange business has not free command of telephones it is practically out of the field. On that account, therefore, we have not much apprehension from the competition with which some imagine we are threatened. But there is another and stronger reason why I do not think we have much to fear from competition of that character, and it is that we have the Postmaster-General's license to establish exchanges in many of the most important towns of the United Kingdom, that we have already established exchanges there, and that we are giving a good, and satisfactory, and cheap service; and therefore we do not think that any competitor would have very much chance of successfully attacking us in any one of those places where we have established our system under the Postmaster-General's license. The Postmaster-General, in a speech which he made in the House of Commons last Saturday, has also, in indicating his change of policy, made some remarks which I think are deserving of the attention of all those who are interested in telephonic enterprise. He says that if the private telephone companies do the telephone business better than the Post Office, the Department would be delighted to have the whole telephone business of the country conducted by private companies. He says, later,

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that if on the other hand it was proved that the business was done better by the Government than by private companies, the Government would have beaten the companies in the free and open field of competition, and they could occupy the ground without any question of purchase arising. Now, the Postmaster-General is a man of very logical mind, who weighs most maturely all his utterances before he puts them in the form of a speech before the House of Commons, and I think we may fairly conclude that he has thoroughly made up his mind before making this speech, and that we may regard it as indicating really his purpose. If, therefore, he is prepared to welcome the development of the private telephone business, if he will be quite satisfied should the telephone companies beat the Post Office in fair competition, if he, as he states, is prepared, that the competition between the Post Office and the companies should be a fair competition, then, I think, we have very little to apprehend from the competition of the Post Office, and I am quite convinced that so long as the present Postmaster-General is in office we shall only be exposed to a fair competition from the Department. The Department has some advantages over a private company. It has, first, the advantage of the possession of a very able and experienced staff; it has the advantage of being able to rest upon Acts of Parliament, which enable it, to a certain extent, to dictate terms to those that are to enter into rivalry with the Department; it has also behind it the national purse. On the other hand, however, the private companies have advantages of another character, upon which, I think, they may rely with confidence. They have more elasticity of action; they are better able to secure a large and generous support in the various localities; they mostly have representatives of influence and importance in every district where they do business on their boards of direction, and they are assisted by local boards of influential gentlemen possessing great weight in the various towns where they are aiding to carry forward the business of the company. I think, therefore, that the National Telephone Company, constituted as it is, and relying as it does upon the absolute fairness of the Post Office Department—relying upon it because its experience gives it confidence in the spirit of fairness which actuates the Postmaster-General and his immediate staff—I think, bearing all these things in mind, the National Company may rest perfectly satisfied on the basis on which its business rests. I have to point out to the shareholders that there has been a loss during the current year in the trunk business of the Company, and it may be necessary that I should explain—I think it is necessary that I should explain—what the character of that business is. When the Postmaster-General agreed to grant exchange licenses to the various companies he determined to keep for the Department the trunk business—that is, the telephonic business between town and town, because he apprehended that if he did not the Post Office would lose very seriously in its postal telegraph revenue. After representations made to him he agreed that the Post Office should itself erect communications between our central exchanges in different towns. For example, the Postmaster-General has given us communication between Leeds and Bradford by a wire erected by the Post Office, but the terms on which that privilege is granted to us are these—that we pay the Postmaster-General for eight subscribers, whether we obtain eight subscribers or not, and we have, in order to develop telephonic enterprise in our various districts, run the risk of paying the Postmaster-General for a trunk wire without having in the first instance secured the necessary number of subscribers. In some cases we have only obtained three subscribers where we have paid for eight. You will say it was, perhaps, unwise for the Company to have agreed with the Postmaster-General for the erection of these wires without having first secured the number of subscribers required by the Postmaster-General. It was, however, thought wise, in the public interest and for the sake of developing telephonic enterprise, to run some risk, and in Yorkshire we ran the risk of coupling up the various towns in which we are interested, and agreeing to pay the Postmaster-General for nine different trunk wires. One effect of the course we have pursued in this—the *Leeds Mercury* has become a subscriber to every one of our trunk wires and every one of our exchanges, and it is enabled, through the assistance it obtains from our association, to hold communication with its agents in the principal towns of Yorkshire a minute or two before going to press. Had we not run the risk of incurring some loss in adopting the trunk system the *Leeds Mercury* would not have been able to do that, and the example of its action in the development of telephonic enterprise would have been lost to the public. I have, however, great confidence that before long there will be a change in the arrangements of the Department with reference to the trunk system. The inclination, so far as I have been able to gauge it, of the Postmaster General, and of the Post Office Department, is gradually and quietly to feel its way, and as it discovers that an alteration of system is beneficial to the public and to the companies, without being detrimental to the interests of the Department, it is disposed to make the change which seems to be indicated in the circumstances. I have, therefore, great confidence that before we meet the shareholders next year I shall be able to announce that the trunk system is upon a better footing. I am quite certain that if we were as free with respect to the trunk system as we are with the exchanges we should be able to give a better and more valuable service to the public. I have thought it necessary to enter into these explanations for two reasons: one, that the shareholders may understand our position in this important matter; and the other, that our subscribers may understand that we are incurring this risk, and giving the advantages of this service, at a loss to the Company. There is, I think, nothing further for the moment that I desire to bring before the shareholders. I think they will be satisfied with the progress which the Company has made. I feel confident that we shall be able to put before you a better and a more favourable report, showing a large balance, another year, and I have great confidence in the success of our enterprise. I may, however, return to the subject of the Post Office, in order to refer to one remark of the Postmaster-General, which I think it is as well that I should make an allusion to. The Postmaster-General is apprehensive lest an idea that the Government intends taking over the telephone companies should lead to speculation in the shares, and unduly enhance their value. I must say that, for this Company, I learnt with great satisfaction that the Postmaster-General has no idea of purchasing the telephone companies. When the Postmaster-General granted us our exchange licenses he reserved to himself the right to take over the companies at a given price—at valuations based on certain principles. He is entitled under those licenses to take over most of the exchanges of this Company in the year 1890. If I could have put him off to the year 1990 I should have preferred to do so, and, therefore, I learn with satisfaction that it is not the intention of the Postmaster-General to buy the telephone companies. All that we ask is to be left as much as possible by ourselves, to enter fairly into competition with other telephone companies and the Post Office, and to be sure, if we make our business successful, that we shall enjoy the fruits of our enterprise without the risk of it being taken over by the Government. I now beg to move "That the report be passed by the shareholders."

Mr. W. A. Smith (a director): I rise in order to second the resolution which Colonel Jackson has just proposed, that the report and balance-sheet now presented be accepted by the shareholders. After the chairman's very exhaustive statement I do not think there is very much left for me to say. I can only heartily endorse everything that he has said, and I would specially point out to you, as one of the best features in the report, the fact that this, although called our second annual meeting, is really our first, as the last annual meeting was almost a statutory meeting, being shortly after we established our business, and that in the brief space of one year we have more than doubled our revenue. I do not require to point out to you what a very good point this is in our balance-sheet, because there are many charges which are fixed, or practically fixed, and if our revenue goes on increasing, as I have no doubt it will in future years, as it has done in the past, the result cannot fail to be highly satisfactory to all the shareholders. I have, therefore, great pleasure in seconding the resolution proposed by the chairman.

The report was adopted, the retiring directors—Messrs. J. Garnett, J. Bruce, and W. A. Smith—were re-elected, as were the auditors, Messrs. Quilter, Ball, and Co., and a vote of thanks to the chairman and directors terminated the proceedings.

SOUTH EASTERN (BRUSH) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of the members of this Company was held at the Cannon-street Hotel on the 24th inst. for the purpose, if thought proper, of confirming the special resolutions, modifying the Articles of Association, passed at the extraordinary general meeting of the Company held on the 9th inst., Sir Michael Kennedy presiding.—The Secretary (Mr. Alfred Jermyn) having read the notice convening the meeting, the Chairman formally moved the confirmation of the resolutions, as follows:—"That the Articles of Association of the Company be, and the same are hereby altered as follows—1. By the insertion of the following words at the end of Article 4:—'Provided always that no share shall be issued at a discount without the sanction of a general meeting.' 2. By the alteration in Articles 81 and 89 of '1886' therein mentioned to '1884.' 3. By the omission of Articles 85 and 100."—Mr. Thomas Fry seconded the motion, and it was carried unanimously.—The proceedings then terminated.

PROVINCIAL (BRUSH) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of the members of this Company was afterwards held, Sir M. Kennedy presiding, when similar special resolutions, which were also passed at the extraordinary general meeting held on the 9th inst., were confirmed.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Aug. 23.		Business Done Week Ending Aug. 23. Highest.	Lowest
Anglo-American	50,	51	50⅜	49⅜
Do. Preferred	80,	81	80½	79
Do. Deferred	19½,	20½	19¾	19½
Brazil Submarine	11⅝,	11⅞	11 13-16	11⅝
Cuba	9½,	10	—	—
Do. Preference	16,	17	—	—
Direct Spanish	6,	6½	6	6
Do. Preference	15½,	16½	15½	15½
Direct United States Cable	11½,	12	11¾	11 9-16
Eastern Telegraph	10½,	10¾	10 13-16	10½
Do. 6 per Cent. Preference	12¾,	13	13	12¾
Do. 5 per Cent. Debentures, 1899	100,	105	—	—
Eastern Extension	11⅛,	11⅜	11 5-16	11 3-16
German Union	9¾,	10¼	10⅛	9¾
Globe Telegraph and Trust Company.	6¼,	6½	6½	6⅜
Do. Preference	12⅝,	12⅞	12¾	12⅝
Great Northern	12¼,	12¾	12⅝	12⅜
Indo-European	29,	30	—	—
Mediterranean Extension	2,	2½	—	—
Do. Preference	8½,	9	—	—
Reuter's	12¾,	13¼	—	—
Submarine	255,	265	—	—
West India and Panama	1¾,	2	1 15-16	1⅞
Do. 1st Preference	8½,	9	8¾	8 7-16
Western Brazilian	6¾,	7¼	6 15-16	6⅝
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	103,	106	—	—

TELEPHONES.

Companies.	Closing Prices Aug. 23.		Highest.	Lowest
Consol. Telephone and Maintenance	1⅛,	1⅜	1 5-16	1¼
Oriental	⅜,	⅝	½	½
United Telephone	9½,	10	10¼	9 9-16

ELECTRIC LIGHT.

Companies.	Closing Prices Aug. 23.		Highest.	Lowest
Electric Light & Power (now Maxim-Weston Electric Light and Power).	⅜,	½	½	⅜
Anglo-American Brush	12,	13	16	11½
Eastern Electric	1,	—	2	1

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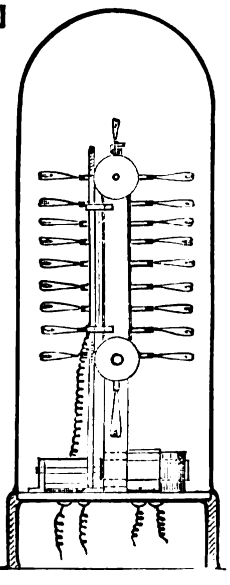
RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

4439. IMPROVEMENTS IN INCANDESCENT ELECTRIC LAMPS, *J. Jameson, Newcastle-on-Tyne. 12th October*, 1881. 6*d*.

The inventor mounts a set of carbons on a series of bars fitted on an endless band, operated by an electro-magnet placed inside the globe, which, when contact is made, attracts an armature, and thereby gives motion to worm wheels keyed on the spindle of the rollers carrying the endless band. The figure explains the invention.

4439

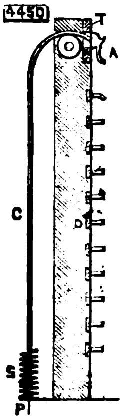


The top carbon only is in circuit. The inventor also provides a means for cleaning the inside of the lamp without destroying the vacuum. He places a pad with an iron core in the interior, and so arranges that it can be passed up into the interior of the lamp and made to touch the glass; it is then caused to rub the surface by the attraction of a strong magnet held outside.

4450. AN IMPROVED METHOD AND APPARATUS FOR EFFECTING TELEPHONIC COMMUNICATIONS, *J. Imray, London.—12th October*, 1881. —(*A communication from J. M. Stearns, jun., Brooklyn, New York.*) 6*d*.

This invention relates to an arrangement of the line wires and their connections at the exchange, so as to facilitate the making and breaking telephonic connections. The figure shows a section of a switch board. Wire P at back of board is attached to spring S, and continued upwards in a flexible conductor, C, passing over a pulley at top

4450

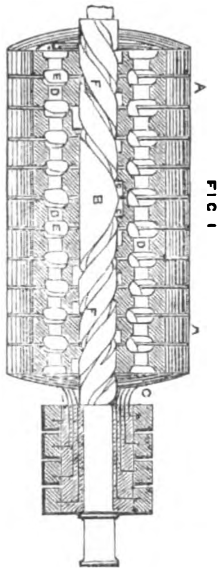


and attached to metal ring A, having a collar by which the strain of S is pulled against insulated metal bar T, and is in electrical contact therewith. D D, &c., are insulated metal bars in front of board with metal hooks, on which ring A can be hooked. Bar T is connected through a call and telephone receiver to battery, D being in connection with subscribers' lines. To connect two subscribers two rings, A, are pulled down and hooked on to same bar D.

4559. IMPROVEMENTS IN APPARATUS FOR GENERATING AND UTILISING ELECTRICITY, *F. M. Newton, Boston Grange, near Taunton.—19th October*, 1881. 6*d*.

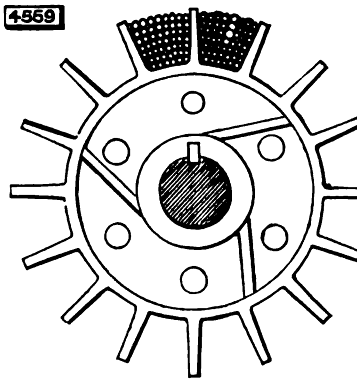
This invention relates to a dynamo machine and arc lamp. The figures show the mode of construction of the armature of the machine. It is formed of a number of cast-iron discs, A, wider at their bosses, C, than elsewhere, thus leaving a space between each for air

4559



circulation. Each disc is pierced with holes, D, and provided with wings, E, to cause the circulation of air drawn in through D and helical grooves F F in shaft B. Each disc is provided with a series of grooves, in which eight coils of insulated wires are wound, so as to form four circuits. Fig. 1 shows the construction of the commutator, Fig. 2 being a section of the armature.

4559



With regard to the lamp the inventor claims the use for regulating the field of an electrode, of a roller in conjunction with an inclined surface in a moving part controlled by a magnet and a fixed arm, the arrangement being such that when the moving part controlled by the magnet moves beyond a certain point the roller is forced by the arm out of contact with the electrode, and the latter is liberated.

4659. IMPROVEMENTS IN LIGHTING BY GAS AND ELECTRICITY COMBINED, *R. H. Courtenay, London.—25th October*, 1881. 6*d*.

This consists in combining a strip of metal composed of an alloy of platinum and iridium—through which a current of electricity is made to pass—with a gas-burner, so that the former is heated by the latter, it being found that the heat from the burner effects a great saving in the work to be done by the current in producing a joint illumination, whilst the current produces more perfect combustion and more light from the gas.

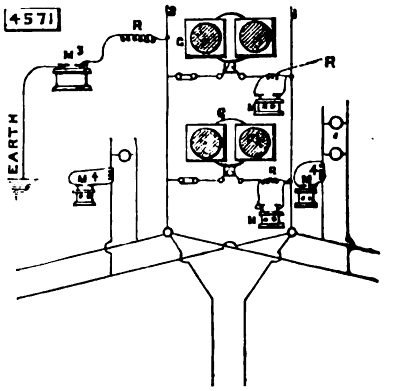
4664. IMPROVEMENTS IN ELECTROMETERS, *J. Imray, London.—25th October*, 1881.—(*A communication from J. Carpentier, Paris.*)—(*Not proceeded with.*) 2*d*.

This relates to improvements in apparatus for measuring the relative intensity of two electric currents, and also for ascertaining under certain conditions their relative electromotive force, and for measuring resistance.

4571. IMPROVEMENTS IN THE MEASUREMENT OF ELECTRICITY IN DISTRIBUTION SYSTEMS, *E. G. Brewer, London.—19th October*. 1881.—(*A communication from T. A. Edison, Menlo Park, U.S.*) 6*d*.

The object of this invention is to furnish a means for determining the aggregate consumption of electricity in a distribution system from the central station where no individual meters are employed, or for ascertaining at the central station the correctness of the total consumption shown by all the house meters, so as to compare the meter accounts, and also at the same time to determine the amount of leakage. At the central

4571

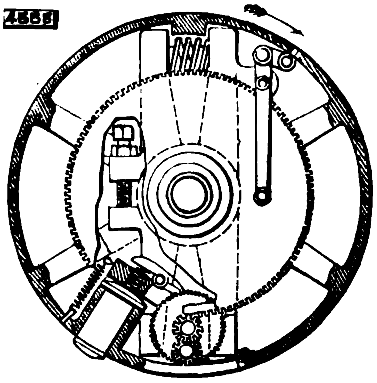


station a meter is placed which will give the total current generated by the dynamo and thrown into the main circuit, and also a meter for recording the total leakage, the difference between the records of the two being the total amount consumed. The figure shows the method of connecting up the meters, &c.: 1 and 2 are main conductors, G G dynamos; M M are current meters, and M^3 leakage meter, M^4 being house meters, and R resistances to shunt only a definite proportion of the current through the meters.

4558. IMPROVEMENTS IN OR APPLICABLE TO REGISTERING DYNAMOMETERS, &c., *W. P. Thompson, Liverpool and London.—19th October*, 1881.—(*A communication from the Transmitting Dynamometer Company, New York.*) 6*d*.

The invention consists in applying to a pulley a rotating dial plate which joins in the rotating movement of the pulley, but has an independent rotation movement of its own either slightly faster or slower than that of the pulley, and in placing against the said dial a pencil, which is fitted into a jointed arm capable of vibratory movement, so that the variations of pressure

4558



imparted to a spring or springs by an arm or arms transmitting the movement of the shaft to the pulley, or *vice versâ*, will control the movement of the said pencil-holder and cause it to mark on the dial the varying positions of said pencil, the pencil-holder revolving with the pulley. The dial plate has an independent movement, however, and by the differential speed between the pencil-holder and the dial one is enabled to make progressive lines on the dial, indicating the variations of power transmitted. The figure will show how this is done.

4694. IMPROVEMENTS IN APPARATUS FOR ACTUATING SIGNALLING APPARATUS ON RAILWAYS BY MEANS OF ELECTRICITY, *E. Edwards, London.—27th October*, 1881.—(*A communication from E. Lesbros, Valence, France.*)—(*Not proceeded with.*) 2*d*.

This relates to discs or other signals, the position of which can be varied as desired, used on railways, and actuated at a distance.

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SLIP

Russia.—The death is announced of Privy Councillor Von Lüders, the Director-General of Russian Telegraphs.

Patents.—For the year ending the 31st of March, the stamp duty on patents for inventions yielded £197,474 14s.

Brazilian Submarine Telegraph Company.—The traffic receipts of this company for the week ended 25th inst. amounted to £3,106.

Swan's Lamp in America.—The Swan Incandescent Electric Light Company, of Boston, has been established, and are setting up plant at their new workshop in Hampden-street, Boston, U.S.A.

Reduction of Australian Telegraph Tariffs.—News from South Australia states that the rates of telegraphic messages on the Port Darwin line are to be reduced from 10s. to 6s. for every ten words.

Underground Wires in America.—It is said that an attempt will soon be made by the authorities of the Pennsylvania Railroad Company to lay their telegraph wires on the New York division underground.

Electrical Power Storage Company.—We are informed that this company has now taken permanent city offices at 4, Great Winchester-street-buildings, E.C., where they have moved from their temporary offices at 74, Hatton-garden, E.C.

The London-Platino Brazilian Telegraph Company.—The revenue of this company for the month of May is estimated at £1,452 (Western Brazilian portion £897, land lines £555), as against £2,345 for the corresponding period of 1881.

India Rubber in Ceylon.—The planters of Ceylon have recently taken to growing india rubber-yielding plants. It is stated that a considerable amount of success has already been attained, and that the trees promise to flourish well in the colony.

Electric Light in Theatres.—M. Jaspar has been experimenting with Maxim incandescent lamps as a means of lighting the Theatre Royal at Liege, in Belgium. The current is supplied by a dynamo placed in M. Jaspar's workshops 500 metres distant.

Electric Lighting at Plymouth.—At the Annual Show of the Plymouth Horticultural Society, held on the 15th and 16th inst., in the Guildhall, a portion of the large tent was lit up by the Edison Electric Light Company with sixty incandescent lamps.

The Lighting of Aberdeen Market.—A contract has been concluded for the restoration of Aberdeen Market, recently destroyed by fire, and it has been proposed to light the new buildings by electric lights. Nothing definite has, however, been settled yet.

Western and Brazilian Telegraph Company.—The traffic receipts of this company for the week ending 25th August, 1882, were £2,087, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

The Lancashire and Cheshire Telephone Exchange.—At the meeting of shareholders of the Lancashire and Cheshire Telephonic Exchange Company, convened for September 11, the directors will recommend a dividend at the rate of 5 per cent. per annum.

Electric Light in Colchester.—The South Eastern (Brush) Electric Light Company are about to start a central lighting station in Culver-street, Colchester. The company are now engaged in erecting their lights in the establishment of Messrs. E. S. Sanders and Son, of that town.

The Telephone at Derby.—Messrs. John Davis and Son, of Derby, have erected a telephone line between the mills of Messrs. Peters and Co., at Derby, and Borrowash, a distance of five miles. The Gower-Bell instruments are employed, and are said to work satisfactorily.

Electric Light in America.—According to an American contemporary, the Brush Electric Light Company have obtained a five years' contract for illuminating the cities of Rock Island, Ill., and Fond du Lac, Wis., and will start their tower system within three months at these places.

Edison's System at Stockholm.—We learn that a most successful exhibition of Edison's system has been made at Stockholm by Edison's Foreign Electric Light and Motive Power Company. The same company have also in hand installations in China, Japan, and the Straits Settlements, as well as on the Continent.

Electric Exhibition at the Westminster Aquarium.—The prize lists connected with this forthcoming exhibition are now to be had upon application to Captain Hobson, the manager, or to W. D. Gooch, Esq., 17, Royal-exchange, London, E.C. The prizes offered for electric motors appear to be deserving of special attention.

The Cutting of the Turkish-Egyptian Wires.—According to a telegram from Constantinople, dated the 24th August, the Porte has addressed a protest to Lord Dufferin concerning the interruption of telegraphic communication with Egypt, the Turkish Government being now unable to communicate with Medjaz and Yemen.

Electric Light at Southampton.—During the meeting of the British Association at Southampton, the theatre of the Hartley Institution, with the entrance hall and entrance room, was lit up by the Edison system. About 150 lamps were used, driven by two Z, or 60-light machines. Over the stage the name "Edison" was shown, illuminated by 65 B, or 8-candle lamps.

The Edison System in New York.—The work of completing the arrangements for lighting a portion of New York by the Edison system is now almost completed. It is reported that the testing of the underground mains has resulted most satisfactorily, and that in all probability this portion of the city will be lighted by Edison lamps for the first time during the forthcoming week.

The Telephone in America.—A telephone line has been established between Clinton, Iowa State, and Davenport, which unites the exchanges of Clinton, Lyons, Camanche, De Witt, Davenport, Muscatine, Iowa, and Albany, Fulton, Morrison, Sterling, Rock Island, Moline, Genesee, and other Illinois points. The longest distance, says *Engineering News*, is between Sterling and Muscatine, 105 miles.

Electric Light for Shops.—Messrs. Shoolbred and Co., of Tottenham Court-road, W., have forty electric lamps now in use, at least so says the *Daily News*, and we have no reason to doubt the fact; but surely what follows is slightly inaccurate. Our contemporary says that the lamps are "supplied by two eight horse-power engines, each engine worked by a Gramme machine of twenty lights!"

Another African Cable.—A Reuter's telegram from Cape Town, dated August 8, states that at a meeting of the Cape Town Chamber of Commerce, held on the 7th August, a resolution was unanimously carried in favour of a western line of cable between this colony and England, connecting at St. Vincent. Letters were read from a number of other Chambers in the colony approving of the proposal.

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"ASBESTITE."—Such is the title given by the United Asbestos Company of 161, Queen Victoria-street, E.C., to a new insulating material which they have recently perfected. It is, of course, a development of asbestos as an insulator. The advantages claimed by the company for their new material are—cheapness, that it will resist acid, and will not absorb moisture, and that it will turn well, take a thread, and also polish well.

EDISON'S INCANDESCENT LAMP PATENTS.—With reference to our Note of last week under this head, Mr. R. H. Milne, secretary to the British Electric Light Company, states that the agreement by that company to pay a royalty to the Edison Company refers solely to a feature in the construction of the incandescent lamps manufactured by the British Electric Light Company which the directors were advised was an infringement.

CRYSTAL PALACE.—Mr. G. Reay-Mackey, late Assistant Paymaster Royal Navy, and secretary to Admiral Rice and Admiral Luard, at Malta, has been appointed manager of the Crystal Palace; and Mr. G. G. Cleather, manager of the Scarborough Aquarium, and late secretary of the Whitby and Scarborough Railway, has been appointed assistant manager. Major Flood Page, the late manager, will leave for Australia, in the Orient steamship "Austral," on September 7.

NATIONAL TELEPHONE CONVENTION IN AMERICA.—The fourth meeting of the National Telephone Exchange Association is to be held at Boston, and will commence on the 5th September. Committees have been appointed to consider the following subjects:—Legislation, Central Office system and apparatus and exchange statistics, line construction and maintenance, cables and subterranean systems, call bells, telephone supplies, electrical disturbances, and exchange rates—eight in all.

THE TELEPHONE AT SOUTHAMPTON.—During the meeting of the British Association at Southampton extensive use was made of the telephone, all the sectional meeting places being connected with the reception room by this means. At the latter place a black board was kept, and on it was registered the exact progress made by each section, and what paper would be read next, the information having been previously telephoned from the section to the reception room. The Gower-Bell instruments were used.

GLOVER'S PATENT COVERED IRON WIRE.—It is well known that overhead telegraph wires erected in the vicinity of large works are soon destroyed by the action of the smoke and fumes given off. Messrs. Walter T. Glover and Co., of Manchester, have invented a special composition for covering such wires, which, it is said, will effectually preserve wires from similar effects. It may also be used for telephone wires as it affords effective insulation. Messrs. Glover have lately received practical evidence of the preservative effects of their composition in the fact that a line running through one of the smokiest districts of Manchester has recently been inspected and found to be in excellent condition, although supplied fourteen years ago.

ANGLO-AUSTRIAN BRUSH ELECTRICAL COMPANY.—We are informed that a committee of the board of directors of this company consisting of Sir W. Stephenson (chairman), Mr. C. K. Stewart, and Mr. Lane-Fox has lately arrived in Vienna, and is now engaged in the preliminaries for the establishment of manufacturing works in that city. The works, which are to be on a very large scale, will be devoted to the manufacture of Brush machines and lamps, Lane-Fox lamps, and the other apparatus connected with the Lane-Fox system. A skilled staff for both manufacturing and general working is being organised under the direction of experienced electricians and engineers formerly in the employ of the Anglo-American Brush Company.

HEARING THE AURORA BY TELEPHONE.—An observer of the recent aurora at Mont Clair, New Jersey, U.S.A., on the 4th August, writes to the *Scientific American* that on connecting the two poles of his telephone, one with the water pipe leading to cistern near his dwelling, and one with the gas pipe leading all over town, he heard the electrical crackle going on, substantially the same as is heard when the same connection is made during thunderstorms. He, however, reports that the auroral crackle was more delicate in its sound than the thunderstorm crackle, and that beside the crackle there were, at intervals of perhaps half a second each, separate short taps on the telephone diaphragm that gave a slight ringing sound. An account of this auroral exhibition will be found in another note.

ELECTRIC LIGHTING AT BIRMINGHAM.—During the Musical Festival now being held at Birmingham, the Town Hall, which has been used for the purposes of the festival, has been most brilliantly lighted by Swan incandescent lamps, nearly 500 of these lamps being used. The current is supplied by a Bürgin dynamo machine, placed in Messrs. Winfield's works in Cambridge-street, and conducted to the hall by underground cables. The lamps are fixed to specially designed brackets, made for the occasion by Messrs. R. W. Winfield and Co., of Cambridge-street, Birmingham, by whom, in conjunction with Mr. R. E. Crompton, the work has been carried out. As we intend to refer to this matter in greater detail in a future issue, we shall not say more about it now, excepting to add that it is one of the largest and best pieces of electric lighting work that has been carried out of late.

FRENCH TELEGRAPHS.—According to recent statistics there are at the present moment in France 5,481 telegraph offices, which in 1883 will be increased to 6,681. The total length of the telegraph lines, which in 1878 was 57,090 kilometres, and in 1881 73,944 kilometres, will at the end of this year amount to 87,020 kilometres. The length of the wires on these lines was in 1881 211,873 kilometres; in 1883 it will amount to 263,000 kilometres. In addition to these overhead lines, 1,132 kilometres of underground lines have been laid, and it is calculated that by the end of this year 2,190 more kilometres will be completed. These 3,322 kilometres of subterranean telegraph cable will have cost about twenty-eight million francs. In 1883 it is proposed to lay 1,355 kilometres of new underground cable. The total length of the subterranean lines it is now proposed to lay is 7,296 kilometres, the cost of which is estimated at fifty-four million francs.

THE FYFE-MAIN LAMP AT SOUTHAMPTON.—During last week some very successful experiments were made with the Fyfe-Main arc lamp, as an illuminant for the docks at Southampton. A powerful lamp was fixed on the north side of the chimney tower, and lighted up the whole area of three of the graving docks and right across the basin; while by means of a reflector the opposite side of the docks was also well illuminated. In addition to this there were four of these lamps in the sheds on the extension Quay, fitted with globes for subduing the brilliancy of the arc, which effectively lit up the space around them, and would have sufficed for a much larger area. The motive power was furnished by a ten horse-power engine placed in the engine house. The experiment has been attended with complete success, and the

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steadiness of the light has been greatly admired. The light was well seen by the excursionists on Saturday last as their steamer came back from Alum Bay.

THE TELEPHONE FOR DIVING WORK.—On the suggestion of Mr. H. H. Wake, the engineer to the River Wear Commissioners, the telephone has been applied as a means of signalling from the workmen in the commissioners' diving bell, and the workmen in charge of the crane and air-pump for governing the bell on the craft employed for submarine work. On Saturday last Mr. A. W. Heaviside, the superintending engineer of the Post Office telegraph system, and Mr. H. H. Wake made a successful trial at the entrance to the South Dock, Sunderland. The signalling between the man in charge of the diving bell at the bottom of the river and the man in charge of the machinery in the craft at the surface was all that could be desired; in fact, everything that proceeds within the bell (says the *Newcastle Daily Chronicle*) can be heard above, every stroke of the hammer or whisper of the men. It is worthy of remark that in this application of the telephone the workmen in the bell have no necessity to speak into the telephone whatever. So long as the telephone is within the bell it records all that is passing. An illustration of its use in this way will be given at the North-East Coast Marine Exhibition, shortly to be opened at the Tynemouth Aquarium.

THE DIFFICULTIES OF CABLE REPAIRING.—On Monday morning last the Telegraph Construction and Maintenance Company's cable ship "Scotia," engaged in repairing the French Atlantic cable, put back into Plymouth from the Atlantic for the second time in two months. When, in May last, the "Scotia" left London she had on board some 4,000 tons of cable stored in her tanks. About 1,000 miles from Brest the cable was picked up and repaired, and the vesse returned to within 400 miles of Brest to make good another fault. Upon this work being taken in hand it was found that the American end of the cable had broken again some 20 miles east of the original breakdown. Buoying the cable, the "Scotia" came on to Plymouth, shipped coals, and provisions, and left. The cable off Brest was spliced, and the "Scotia" sought the new fault. This was discovered, but considerable trouble was experienced in the endeavours to repair it. The cable has several times chafed at the bottom and parted, with the result that, after a month's work, affairs remain practically as before. One end is now buoyed; the other is at the bed of the sea. During the operations 140 miles of cable have been paid out.

COPPER-PLATING WITH DYNAMO MACHINES.—Recently a party of gentlemen connected with the Postal Telegraph Company of New York visited the plant, now purchased by the company, for coating steel telegraph wire with copper The mill where the copper-coated, steel-cored wire is made for the company was formerly occupied by Wallace and Sons, who first made wire of this character. The mill contains 200 vats filled with a solution of blue vitriol. Twenty-five large dynamo machines furnish the current necessary for the electro-plating process. In the vats, at the time of the visit, undergoing the process of coating, were seventy-five miles of steel wire, which is sent slowly winding over a spiral coil through the vats until a sufficient coating of copper is obtained, this process occupying sixty hours. From each ton of the copper used in this operation, between 15 and 20ozs. of silver are precipitated in the bottom of the vats, a quantity, says the *Engineering and Mining Journal*, claimed to be sufficient to pay the actual expenses of the coating process. The rate at which the steel wire of 200lb. weight to the mile is coated with 500lb. to the mile of copper, with the existing facilities, is ten miles per day. Two other engines are erecting which will give the factory a capacity of thirty miles per day.

LEEDS TOWN COUNCIL AND ELECTRIC LIGHTING.—A special meeting of the Leeds Town Council was held on Friday, the 25th August, to consider the provisions of the Electric Lighting Act, 1882. The Town Clerk presented a report on the Act, and the Board of Trade rules in connection with it, which stated the facts of the case most ably. The first few words of this report may be quoted here. They are as follow:—"Notwithstanding the apprehension which has been expressed in some quarters with regard to this Act, it will be found, upon considering it in connection with the rules which have been promptly issued by the Board of Trade under its provisions, that there is really no question arising out of it which need excite alarm on the part of municipal corporations or local authorities. The provisions which have been embodied in the Act and rules at the instance of municipal corporations throughout the country have constituted such corporations as that of Leeds practically masters of the situation within the area over which they exercise the jurisdiction of local authorities." The report then proceeded to analyse the provisions of the Act, and having been read, was ordered to be printed and circulated amongst the members. A member then moved the appointment of a committee of 23 members of the council "to consider and report to the council on all matters affecting the council as the local authority arising under and by virtue of the Electric Lighting Act, 1882;" which was at once seconded and carried.

REPORT OF THE CIVIL SERVICE COMMISSIONERS.—According to the twenty-sixth report of these commissioners upon the examinations held during 1881, 24,243 cases were dealt with, as compared with 20,452 in the preceding year, the increase being mainly due to the introduction of open competition for the situations of telegraph learner and female clerk in the Post Office. In the early part of 1881, according to this report, the Postmaster-General determined, with the consent of the Treasury, to throw open to public competition the situations of female clerk and of female (as well as male) telegraph learner in his Department. The first open competition for female clerkships in the London offices took place in September in London, Edinburgh, and Dublin. The candidates competed in the following subjects:—Arithmetic, spelling, English composition, geography, and English history, having been previously tested in the simpler parts of arithmetic, as well as in spelling and handwriting, at a preliminary examination held in various towns. Out of 747 candidates, 525 failed to satisfy the preliminary test, five after passing it declined to proceed further, and 217 competed for 76 appointments, being the number estimated as likely to become vacant within the following six months. For the situation of male telegraph learner four open competitions have been held in London, and 934 candidates offered themselves for 345 appointments. For the situation of female telegraph learner one competition took place in London in June last, at which 448 candidates offered themselves for 40 appointments.

ELECTRIC LIGHT IN EDINBURGH.—On Saturday evening (says the *Scotsman*) the new electric lamps at the Waverley Station were lighted for the first time, and attracted much notice, the lights burning with steadiness and brilliancy. In this respect, judging from Saturday's trial, they compared advantageously with the Prince's-street experiments of a year ago—one reason, no doubt, being that the

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superintending electrician had more time and skilled labour at his disposal than were available for the execution of the work done at the instance of the Corporation. The splendid 40-light dynamo-machine and the Yorkshire engine with which it is driven worked very quietly. The former, to supply the Brush lamps at present on the circuit —twenty in the station and its precincts and one in the engine room—was run at 570 revolutions a minute. By the officials of the Railway Company the lighting of the whole station by electricity is regarded with satisfaction as conducing to the safer conduct of the daily increasing traffic. Not only the one platform but the whole space between the boundary wall on the north side and the goods station will now be brilliantly illuminated at night, rendering the approach of trains from east and west clearly distinguishable. The contract for the lighting of the station has, it should have been stated, been made with the Brush Electric Light and Power Company of Scotland (Limited), and not the Scottish Brush Electric Light and Power Company. Mr. G. W. Beckingsale is the manager and electrician of the former company, and the work has been carried out under the superintendence of Mr. Partridge.

The United States Torpedo Service.—The closing examinations and experiments at the United States torpedo station before the naval Board of Visitors, says *The Operator*, were held at Newport on August 4. The exercises opened with an exhibition by Capt. T. O. Selfridge, the commandant, of his method of defending a ship from attack by launches or mechanical torpedoes. Nets were hung to spars rigged out from the gun-boat "Nina," and so arranged as to yield for a certain distance by sliding in on the boom. After advancing this distance a circuit was closed with a battery on the "Nina" and a torpedo was exploded, pretty thoroughly wetting some of the spectators on the gun-boat. Had an enemy's boat been under the torpedo it would have been destroyed without injury to the vessel it had come to attack. Next followed a run by a mechanical launch which dropped a counter-mine of dynamite and then returned. The mine was then exploded. The control differs from that of last year in that the electric current is taken from the armature of a No. 8 Maxim machine. Batteries are too inconvenient to be carried on board ship, while a dynamo machine simply requires power and cannot spill. It is proposed that large vessels shall carry a machine which will furnish an electric current either for lights or for a controlled boat, as circumstances require. The examination in electricity was then held. This branch is under the management of Lieut. Commander Caldwell, one of the best informed officers of the navy in this department. The examination took a practical turn, and the class explained the measurement of resistances of machines and batteries and the measurement of electromotive force and currents, and gave a description of the instruments used and the electro-dynamometers. An exhibition of Edison lamps run by a Gramme machine of low resistance and a description of the Brush and Edison systems was also given. The units and constants, and how they were obtained; various fuse measurements, the construction of voltaic and secondary batteries, branch circuits and shunts, galvanometer constants, &c., were explained by the class. There was also a practical demonstration of the converse system of defensive mines. In all the topics discussed the class showed a satisfactory proficiency, when the short term of study is remembered. The transmission of power by electricity was practically shown to the board. A small Gramme sent its current through a Maxim machine, and the latter turned a lathe at a rapid rate. The examination in fuses consisted of a description of the various forms, and a practical exhibition by the class of their manufacture. Each member successfully constructed a certain number of standard fuses and igniters of the various forms. The three days' examination and experiments have passed off without accident and with entire success, showing that the station and its work are a credit to the country.

Recent Aurora in America.—There was a superb exhibition of auroral light on the night of the 4th of August says the *Scientific American*. We do not know how far over the country it extended, but from an elevated locality among the Connecticut hills the celestial show was beautiful in the extreme. The display commenced about 9 o'clock, when the whole northern sky was illuminated with a light of surpassing softness, singularly colourless and serene in aspect, like the breaking of the dawn on a summer morning, or the silvery light that attends the rising of the summer full moon. The quiet phase was of short duration. The arch of white light widened and broadened, encroaching on the east and west, and touching the south with delicately penciled rays. The colouring took on bluish and greenish tints. Streams of light darted from the north, north-west, and north-east, reaching to the zenith, and dimming the lustre of the bright stars, upon whose domains they ruthlessly intruded. Two brilliant streamers met above Arcturus, surrounding the ruddy star with a transitory corona; others threw their ethereal beams over the Great Dipper, the Polar Star, and Cassiopea, immersing them in a hazy light, through which the stars glimmered and twinkled in subdued brightness. The lesser stars ceased to shine amid the all-pervading glow, and a portion of the Milky Way, grandly defined in the earlier evening, was completely hidden from view. The scene changed with every glance to the heavens. The streamers dissolved, new ones took their places, waves of brightness undulated over the sky, celestial banners were unfurled, and squares and triangles mingled in the celestial architecture, the varied forms making their rapid course over the sky, now uniting in vast masses, now breaking in pieces, now joining in bands, and now rolling out into vast draperies, with which to curtain the sky. About ten o'clock the show reached its culmination with a grand *finale* in the north east, in which the most brilliant features of the display were concentrated in the closing scene. The light was like that with which in high localities the sun some times irradiates a portion of the landscape while the rest is left in shadow. Thus the aurora lighted a hill-side in the distance, and thus this weird agent of the sun threw its beams through the trees in a neighbouring pine grove, distinctly outlining their forms and gleaming like sunlight between their trunks and branches. A charming feature of the show was the fall of three meteors from the bowl of the Dipper. The first and third were of the ordinary kind, but the second was as large as a star of the first magnitude, and, as it exploded, left behind a train of crimson light, thus furnishing, for a few seconds, the one element that was wanting to the perfection of the exhibition. For, unlike the grand display of the 16th of April, in which all the hues of the rainbow were represented, the aurora was almost colourless, being white, slightly tinged with blue and green. At 10 o'clock the moon made her appearance upon the scene, and, though in waning glory, her light was sufficient to break up the brilliance of the show. When, at the latest observation, she was nearly half way to the zenith, the north-western sky had resumed its normal condition, though auroral banners were still faintly floating in the north east.

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ON A NEW ARC ELECTRIC LAMP.*

BY W. H. PREECE.

Electric lamps on the arc principle are almost as numerous as the trees in the forest, and it is rather refreshing to come upon something that is novel. In these lamps the carbons are consumed as the current flows, and it is the variation in their consumption which occasions the flickering and irregularity of the light that is so irritating to the eye. Special mechanical contrivances, or regulators, have to be used to compensate for this destruction of the carbons, as in the Siemens and Brush type, or else refractory materials have to be combined with the carbons, as in the Jablochkoff candle and in the lamp Soleil. The steadiness of the light depends upon the regularity with which the carbons are moved towards each other as they are consumed, so as to maintain the electric resistance and constant quantity. Each lamp must have a certain elasticity of regulation of its own to prevent irregularities from the variable material of carbon used, and from variations in the current itself and in the machinery.

In all electric lamps, except the Brockie, the regulator is in the lamp itself. In the Brockie system the regulation is

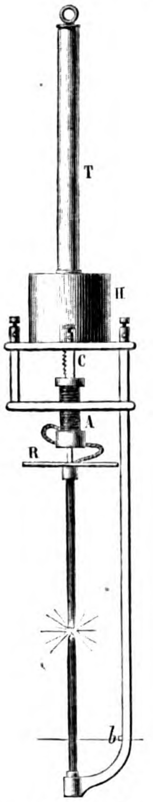

FIG. 1.—Abdank's Arc Lamp.

automatic, and is made at certain rapid intervals by the motor engine. This causes a periodic blinking that is detrimental to this lamp for internal illumination.

M. Abdank, the inventor of the system which I have the pleasure of bringing before the section, separates his regulator from his lamp. The regulator may be fixed anywhere, within easy inspection and manipulation, and away from disturbing influence in the lamp. The lamp can be fixed in any inaccessible place.

The Lamp.—The bottom or negative carbon is fixed, but the top or positive carbon is movable in a vertical line. It is screwed at the point C to a brass rod, T (Fig. 2), which moves freely inside the tubular core of an electro-magnet, K. This rod is clutched and lifted by the soft iron armature A B, when a current passes through the coil M M. The mass of the iron in the armature is distributed so that the greater portion is at one end, B, much nearer the pole than the other end. Hence this portion is attracted first, the armature assumes an inclined position maintained by a brass button, *t*, which prevents any adhesion between the armature and the core of the electro-magnet. The electric connection between the carbon and the coil of the electro-magnet is maintained by the flexible wire S.

The electro-magnet A (Fig. 1) is fixed to a long and heavy rack C, which falls by its own weight and by the weight of the electro-magnet and carbon fixed to it. The fall of the rack is controlled by a friction break, B (Fig. 3), which acts

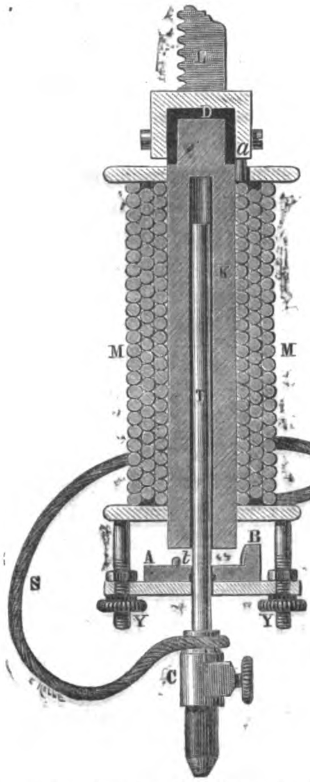

FIG. 2.—Abdank's Arc Lamp.

upon the last of a train of three wheels put in motion by the above weight. The break B is fixed at one end of a lever, B A, the other end carrying an easily adjusted soft iron armature, F. This armature is attracted by the electro-magnet E E (whose resistance is 1,200 ohms) whenever a current circulates through it. Its play is regulated by the screw V. The spring L applies tension to the break.

The Regulator.—This consists of a balance and a cut off.

The balance (Figs. 4 and 6) is made with two solenoids, S S′, whose relative distance is adjustable. S conveys the main current and is wound with thick wire, having practi-

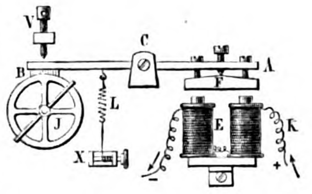

FIG. 3.—Showing Friction Break.

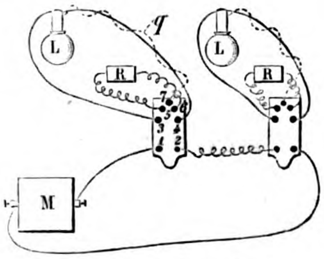

FIG. 5.—Lamps in Series.

cally no resistance, and S′ is traversed by a shunt current, and is wound with fine wire, having a resistance of 600 ohms. In the axes of these two coils a small and light iron tube (2mm. diameter and 60mm. length) freely moves in a vertical line between two guides. Its upward motion is controlled by the spring N T. This spring rests upon the screw H, with which it makes contact by platinum electrodes. This contact is broken whenever the little iron rod strikes the spring N T.

The positive lead from the dynamo is attached to the ter-

* Paper read at the Southampton meeting of the British Association.

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minal B. It then passes through the coil S to the terminal B′, whence it proceeds to the lamp. The negative lead is attached to terminal A, passing directly to the other terminal A′, and thence to the lamp.

The shunt which passes through the fine coil S′ commences at the point P. The other end is fixed to the screw H, whence it has two paths, the one offering no resistance through the spring T N to the upper negative terminal A′, the other through the terminal J to the electro-magnet of the break M, and thence to the negative terminal of the lamp L′.

The Cut-off.—The last part of the apparatus to be described is the "cut-off," used when there are several lamps in series. It is brought into play by switch C D (Figs. 4 and 6), which can be placed at E or D. When it is at E, the negative terminal A is in communication with the positive terminal B,

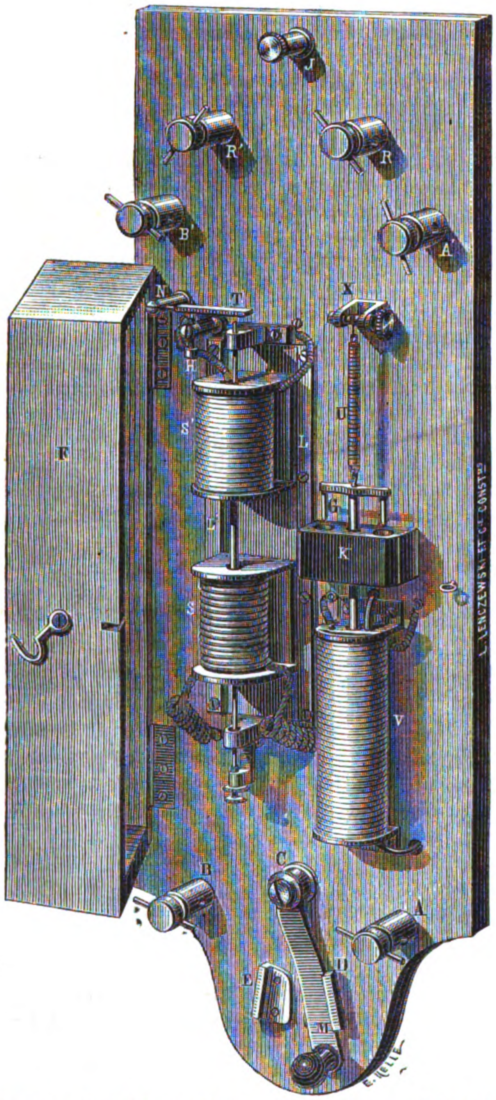

Fig. 4.—Abdank's Arc Lamp. The Balance and Cut-off.

through the resistance R, which equals the resistance of the lamp, which is, therefore, out of circuit. When it is at D the cut-off acts automatically to do the same thing. This is done by a solenoid V, which has two coils, the one of thick wire offering no resistance, and the other of 2,000 ohms resistance. The fine wire connects the terminals A′ and B. The solenoid has a movable soft iron core suspended by the spring U. It has a cross piece of iron, which can dip into two mercury cups, G and K, when the core is sucked into the solenoid. When this is the case, which happens when any accident occurs to the lamp, the terminal A is placed in connection with the terminal B through the thick wire of V and the resistance R, in the same way as it was done by the switch C D.

Electrical Arrangement.—The mode in which several lamps are connected up in series is shown by the Fig. 5. The + lead is connected to B, of the balance; it then passes to the lamp L, returning to the balance, and then proceeds to each other lamp, returning finally to the negative pole of the machine. When the current enters the balance it passes through the coil S, magnetising the iron core and drawing it downwards (Fig. 6). It then passes to the lamp L L′, through the carbons, then returns to the balance, and proceeds back to the negative terminal of the machine. A small portion of the current is shunted off at the point P, passing through the coil S′, through the contact spring T N, to the terminal A′, and drawing the iron core in opposition to S. The carbons are in contact, but in passing through the lamp the current magnetises electro-magnet M (Fig. 2), which attracts the armature A B, that bites and lifts up the rod T with the upper carbon a definite and fixed distance that is easily regulated by the screws Y Y. The arc then is formed, and will continue to burn steadily as long as the current remains constant. But the moment the current falls, due to the increased resistance of the arc, a greater proportion passes

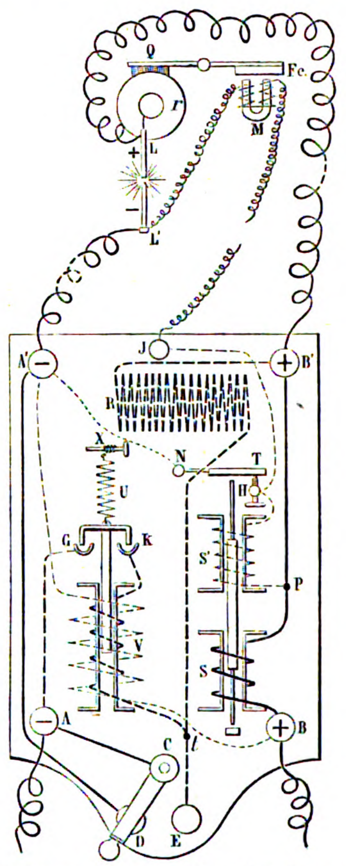

Fig. 6.—Abdank's Arc Lamp. Plan of Balance and Cut-off.

through the shunt S′ (Fig. 4), increasing its magnetic moment on the iron core, while that of S is diminishing. The result is that a moment arrives when equilibrium is destroyed, the iron rod strikes smartly and sharply upon the spring N T. Contact between T and H is broken, and the current passes through the electro-magnet of the break in the lamp. The break is released for an instant, the carbons approach each other. But the same rupture of contact introduces in the shunt a new resistance of considerable magnitude (viz., 1,200 ohms), that of the electro-magnet of the break. Then the strength of the shunt current diminishes considerably, and the solenoid S recovers briskly its drawing power upon the rod, and contact is restored. The carbons approach during these periods only about ·01 to ·02 millim. If this is not sufficient to restore equilibrium it is repeated continually until equilibrium is obtained. The result is that the carbon is continually falling by a motion invisible to the eye, but sufficient to provide for the consumption of the carbons.

The balance acts precisely like the key of a Morse machine,

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and the break precisely like the sounder-receiver so well known in telegraphy. It emits the same kind of sounds and acts automatically like a skilled and faithful telegraphist.

The contact between N T and H is never completely broken; the sparks are very feeble, and the contacts do not oxidise.

The resistances inserted are so considerable that heating cannot occur, while the portion of the current abstracted for the control is so small that it may be neglected.

This regulation, by very small and short successive steps, offers several advantages. 1. It is imperceptible to the eye. 2. It does not affect the main current. 3. Any sudden instantaneous variation of the main current does not allow a too near approach of the carbon points.

Let now an accident occur—for instance, a carbon is broken. At once the automatic cut-off acts, the current passes through the resistance R instead of passing through the lamp. The current through the fine coil is suddenly increased, the rod is drawn in, contact is made at G and K, and the current is sent through the resistance R. As soon as contact is again made by the carbons, the current in the coil S is increased, that in V diminished, and the antagonistic spring U breaks the contact at G and K.

The rupture of the light is almost invisible, because the relighting is so brisk and sharp.

I have seen this lamp in action, and its constancy and steadiness leave nothing to be desired.

THE DETECTION OF ADULTERATION OF METALLIC NICKEL BY THE MAGNET.

By Thomas T. P. Bruce Warren, Professor of Chemical Technology, Silvertown Institution. Analytical Chemist to the India Rubber, Gutta Percha, and Telegraph Company, Silvertown.

During the past winter, whilst lecturing to a class in this institution on electricity and magnetism, I was desirous of showing to the students the magnetic property of metallic nickel. Through the kindness of Matthew Gray, Esq., President of the institution, I borrowed from the India Rubber, Gutta Percha, and Telegraph Company, Silvertown, a specimen of nickel cubes, which consisted, in fact, of two samples received some time ago from Germany. The difference in price of these two samples was so little that they were thrown together into a drawer, as it was thought there could not be much difference between them with respect to purity, &c.

A handful of these cubes was placed on the table, and on bringing an ordinary compound horse-shoe magnet near the cubes I was very much surprised to find that, whilst some of the cubes were forcibly attracted by the magnet, others were not affected at all, or so slightly that they could not be supported by the magnet against their own gravity. Some cubes were attracted slightly when placed very near to the magnet, but could not be lifted.

I thought the matter was of sufficient interest that I entrusted the chemical examination of these samples to one of the students in the laboratory of the institution.

I afterwards examined the whole of the nickel contained in the drawer with the magnet in the same way, and in two or three minutes I had the samples sorted out into their original lots of two kilogrammes each.

The magnet readily picked out the better quality at the rate of twenty or thirty cubes at a time, until what was left could not be drawn out by the magnet. To make sure of the result the "magnetically selected" cubes were again tested with the magnet, when it was found that a few non-magnetic cubes had been drawn up by entanglement with the others. By the second operation the separation was perfect.

There was no very marked difference in the appearance of these cubes which would lead one casually to suspect anything worth noting. A closer examination showed that the non-magnetic cubes were a trifle whiter, and presented the absence of a striated structure, which was well defined, though in an unequal degree, with the magnetic cubes.

The method of examination was extended to samples of English grain nickel, and also to portions of anodes used in nickel plating. The anodes were of English, American, and German manufacture.

It may be sufficient to remark here that the grain nickel was powerfully magnetic, and, like the magnetic cubes, showed distinct polarities. The anodes, although magnetic, were much weaker than the grain sample, but appeared to be attracted equally by the magnet.

The chemical examination of the grain nickel and the anodes here referred to, as well as the double ammonia salts used in plating, will be found in the appendix to this communication.

The fact that nickel has now become an article of considerable commercial importance, and that chemical analysis has disclosed the fact that this metal is liable to an extensive adulteration, and which can be so easily detected by the magnet, led me to believe that this subject deserved a more extended examination.

There is no doubt but that with some of the other metals which are magnetic we may hope to gain information with regard to their purity or adulteration.

For convenience, it will be well to divide the following portion of this communication into two parts. In the first part I propose to deal with the chemical examination of the two samples referred to in the earlier part of this paper, and also to the chemical composition of the anodes and salts used in nickel plating. In the second part of the paper I propose to refer to some experiments which I have made with a view of ascertaining the effects of different metals on the magnetic property of metallic nickel. This part of the investigation will probably lead to an explanation of the singular behaviour of alloys containing this metal.

I have added in the appendix to this paper a few of the details of the analytical methods I have adopted, as well as the precautions which have appeared necessary to eliminate any sources of error in the analytical operations.

The following table gives the percentage composition of the two samples of nickel cubes:—

	Magnetic.	Non-magnetic.
Copper	·083	33·779
Carbon	·071	·365
Silica	·409	·160
Iron	2·457	·841
Arsenic	·117	·865
Tin	·749	·461
Nickel	96·670	63·690
	100·556	100·161

Special examinations were made for lead, bismuth, antimony, zinc, cobalt, and sulphur, with negative results, although some of these have been detected in samples of anodes.

A portion of pure oxide obtained from the non-magnetic sample was reduced by heating in a current of hydrogen gas, and which appeared to be even more magnetic than the other sample. This reduced metal, placed in a test tube and inserted between the poles of a strong horse-shoe magnet, readily took up an axial position, which was not disturbed on carefully rotating the tube.

On heating a portion of this metal with arsenic, tin, or antimony, even in very small quantities, the tendency to assume the axial position was decidedly diminished. I have endeavoured to find out to what extent this effect can be carried by alloying the pure metal with the extreme metals of the diamagnetic series.

I have no doubt that this investigation will throw considerable light on that curious phenomenon so well known to electricians, though not explained, that German silver wire becomes thoroughly brittle after a current has been passed through it for a few hours.

As nickel is adulterated so largely with copper, it is easy to explain the great variation which is met with in the specific resistance of German silver wire obtained even from the same manufacturer.

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BRITISH ASSOCIATION.

Presidential Address by C. William Siemens, D.C.L. (Oxon), LL.D. (Glasc. and Dubl.), Ph.D., F.R.S., F.C.S., Member Inst. C.E.

(CONCLUDED FROM PAGE 347.)

In the production of mechanical effect from heat, gaseous fuel also presents most striking advantages, as will appear from the following consideration. When we have to deal with the question of converting mechanical into electrical effect, or *vice versâ*, by means of the dynamo-electrical machine, we have only to consider what are the equivalent values of the two forms of energy, and what precautions are necessary to avoid losses by the electrical resistance of conductors and by friction. The transformation of mechanical effect into heat involves no losses except those resulting from imperfect installation, and these may be so completely avoided that Dr. Joule was able by this method to determine the equivalent values of the two forms of energy. But in attempting the inverse operation of effecting the conversion of heat into mechanical energy, we find ourselves confronted by the second law of thermo-dynamics, which says that whenever a given amount of heat is converted into mechanical effect, another but variable amount descends from a higher to a lower potential, and is thus rendered unavailable.

In the condensing steam engine this waste heat comprises that communicated to the condensing water, whilst the useful heat, or that converted into mechanical effect, depends upon the difference of temperature between the boiler and condenser. The boiler pressure is limited, however, by considerations of safety and convenience of construction, and the range of working temperature rarely exceeds 120° C. except in the engines constructed by Mr. Perkins, in which a range of 160° C., or an expansive action commencing at 14 atmospheres, has been adopted with considerable promise of success, as appears from an able report on this engine by Sir Frederick Bramwell. To obtain more advantageous primary conditions we have to turn to the caloric or gas engine, because in them the coefficient of efficiency expressed by $\frac{T - T'}{T}$, may be greatly increased. This value would reach a maximum if the initial absolute temperature T could be raised to that of combustion, and T' reduced to atmospheric temperature, and these maximum limits can be much more nearly approached in the gas engine worked by a combustible mixture of air and hydro-carbons than in the steam engine.

Assuming, then, in an explosive gas engine a temperature of 1,500 deg. C. at a pressure of 4 atmospheres, we should, in accordance with the second law of thermo-dynamics, find a temperature after expansion to atmospheric pressure of 600 deg. C., and therefore a working range of 1,500 deg. — 600 deg. = 900 deg., and a theoretical efficiency of $\frac{900}{1500 + 274}$ = about one-half, contrasting very favourably with that of a good expansive condensing steam engine, in which the range is 150 — 30 = 120 deg. C., and the efficiency $\frac{120}{150 + 274} = \frac{2}{7}$. A good expansive steam engine is therefore capable of yielding as mechanical work 2-7th parts of the heat communicated to the boiler, which does not include the heat lost by imperfect combustion, and that carried away in the chimney. Adding to these the losses by friction and radiation in the engine, we find that the best steam engine yet constructed does not yield in mechanical effect more than 1-7th part of the heat energy residing in the fuel consumed. In the gas engine we have also to make reductions from the theoretical efficiency on account of the rather serious loss of heat by absorption into the working cylinder, which has to be cooled artificially in order to keep its temperature down to a point at which lubrication is possible; this, together with frictional loss, cannot be taken at less than one-half, and reduces the factor of efficiency of the engine to one-fourth.

It follows from these considerations that the gas or caloric engine combines the conditions most favourable to the attainment of maximum results, and it may reasonably be supposed that the difficulties still in the way of their application on a large scale will gradually be removed. Before many years have elapsed we shall find in our factories and on board our ships engines with a fuel consumption not exceeding one pound of coal per effective horse-power per hour, in which the gas producer takes the place of the somewhat complex and dangerous steam boiler. The advent of such an engine and of the dynamo machine must mark a new era of material progress at least equal to that produced by the introduction of steam power in the early part of the century. Let us consider what would be the probable effect of such an engine upon that most important interest of this country—the merchant navy.

According to returns kindly furnished me by the Board of Trade and *Lloyd's Register of Shipping* the total value of the merchant shipping of the United Kingdom may be estimated at £126,000,000, of which £90,000,000 represent steamers having a net tonnage of 3,003,988 tons; and £36,000,000 sailing vessels, of 3,688,008 tons. The safety of this vast amount of shipping, carrying about five-sevenths of our total imports and exports, or £500,000,000 of goods in the year, and of the more precious lives connected with it, is a question of paramount importance. It involves considerations of the most varied kind, comprising the construction of the vessel itself, and the material employed in building it; its furniture of engines, pumps, sails, tackle, compass, sextant, and sounding apparatus, the preparation of reliable charts for the guidance of the navigator, and the construction of harbours of refuge, lighthouses, beacons, bells, and buoys for channel navigation. Yet, notwithstanding the combined efforts of science, inventive skill, and practical experience—the accumulation of centuries—we are startled with statements to the effect that during last year as many as 1,007 British-owned ships were lost, of which fully two-thirds were wrecked upon our shores, representing a total value of nearly £10,000,000. Of these ships 870 were sailing vessels and 137 steamers, the loss of the latter being in a fourth of the cases attributable to collision. The number of sailing vessels included in these returns being 19,325, and of steamers 5,505, it appears that the steamer is the safer vessel, in the proportion of 4·43 to 3·46; but the steamer makes on an average three voyages for one of the sailing ship taken over the year, which reduces the relative risk of the steamer as compared with the sailing ship per voyage in the proportion of 13·29 to 3·46. Commercially speaking, this factor of safety in favour of steam shipping is to a great extent counterbalanced by the value of the steamship, which bears to that of the sailing vessel per net carrying ton the proportion of 3:1, thus reducing the ratio in favour of steam shipping as 13·29 to 10·38, or, in round numbers, as 4:3. In testing this result by the charges of premium for insurance, the variable circumstances of distance, nature of cargo, season and voyage have to be taken into account; but judging from information received from shipowners and underwriters of undoubted authority, I find that the relative insurance paid for the two classes of vessel represents an advantage of 30 per cent. in favour of steam shipping, agreeing very closely with the above deductions derived from statistical information.

In considering the question how the advantages thus established in favour of steam shipping could be further improved, attention should be called in the first place to the material employed in their construction. A new material was introduced for this purpose by the Admiralty in 1876-78, when they constructed at Pembroke dockyard the two steam corvettes, the Iris and Mercury, of mild steel. The peculiar qualities of this material are such as to have enabled shipbuilders to save 20 per cent. in the weight of the ship's hull, and to increase to that extent its carrying capacity. It combines with a strength 30 per cent. superior to that of iron such extreme toughness that in the case of collision the side of the vessel has been found to yield or bulge several feet without showing any signs of rupture, a quality affecting the question of sea risk very favourably. When to the use of this material there are added the advantages derived from a double bottom, and from the division of the ship's hold by means of bulkheads of solid construction, it is difficult to conceive how such a vessel could perish by collision either with another vessel or with a sunken rock. The spaces between the two bottoms are not lost, because they form convenient chambers for water ballast, but powerful pumps should in all cases be added to meet emergencies.

The following statement of the number and tonnage of vessels building and preparing to be built in the United Kingdom on the 30th of June last, which has been kindly furnished me by Lloyd's, is of interest as showing that wooden ships are fast becoming obsolete, and that even iron is beginning to yield its place, both as regards steamers and sailing ships, to the new material mild steel; it also shows that by far the greater number of vessels now building are ships of large dimensions propelled by engine power:—

	Mild Steel.		Iron.		Wood.		Total.	
	No.	Tons gross.	No.	Tons gross.	No.	Tons gross.	No.	Tons gross.
Steam	89	159,751 ...	555	929,921 ...	6	460 ...	650	1,090,132
Sailing	11	16,800 ...	70	120,259 ...	49	4,635 ...	130	141,694
	100	176,551 ...	625	1,050,180 ...	55	5,095 ...	780	1,232,826

If to the improvements already achieved could be added an engine of half the weight of the present steam engine and boilers, and working with only half the present expenditure of fuel, a further addition of 30 per cent. could be made to the cargo of an

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Atlantic propeller vessel—no longer to be called a steamer—and the balance of advantages in favour of such vessels would be sufficient to restrict the use of sailing craft chiefly to the regattas of this and neighbouring ports.

The admirable work on the *British Navy*, lately published by Sir Thomas Brassey, the Civil Chief Lord of the Admiralty, shows that the naval department of this country is fully alive to all improvements having regard to the safety as well as to the fighting qualities of Her Majesty's ships of war, and recent experience goes far to prove that, although high speed and manœuvring qualities are of the utmost value, the armour plate which appeared to be fast sinking in public favour is not without its value in actual warfare.

The progressive views perceptible in the construction of the navy are further evidenced in a remarkable degree in the hydrographic department. Captain Sir Frederick Evans, the hydrographer, and vice-president of the British Association, gave us at York last year a very interesting account of the progress made in that department, which, while dealing chiefly with the preparation of charts showing the depth of water, the direction and force of currents, and the rise of tides near our shores, contains also valuable statistical information regarding the more general questions of the physical conditions of the sea, its temperature at various depths, its flora and fauna, as also the rainfall and the nature and force of prevailing winds. In connection with this subject the American Naval Department has taken an important part, under the guidance of Captain Maury and the Agassiz father and son, whilst in this country the persistent labours of Dr. William Carpenter deserve the highest consideration.

Our knowledge of tidal action has received a most powerful impulse through the invention of a self-recording gauge and tide-predicter, which will form the subject of one of the discourses to be delivered at our present meeting by its principal originator, Sir William Thomson; when I hope he will furnish us with an explanation of some extraordinary irregularities in tidal records, observed some years ago by Sir John Coode at Portland, and due apparently to atmospheric influence.

The application of iron and steel in naval construction rendered the use of the compass for some time illusory, but in 1839 Sir George Airy showed how the errors of the compass, due to the influence experienced from the iron of the ship, may be perfectly corrected by magnets and soft iron placed in the neighbourhood of the binnacle, but the great size of the needles in the ordinary compasses rendered the correction of the quadrantal errors practically unattainable. In 1876 Sir William Thomson invented a compass with much smaller needles than those previously used, which allows Sir George Airy's principles to be applied completely. With this compass correctors can be arranged so that the needle shall point accurately in all directions, and these correctors can be adjusted at sea from time to time, so as to eliminate any error which may arise through change in the ship's magnetism or in the magnetism induced by the earth through change of the ship's position. By giving the compass card a long period of free oscillation great steadiness is obtained when the ship is rolling.

Sir William Thomson has also enriched the art of navigation by the invention of two sounding machines; the one being devised for ascertaining great depths very accurately in less than one-quarter the time formerly necessary, and the other for taking depths up to 130 fathoms without stopping the ship in its onward course. In both these instruments steel pianoforte wire is used instead of the hempen and silken lines formerly employed; in the latter machine the record of depth is obtained not by the quantity of wire run over its counter and brake wheel, but through the indications produced upon a simple pressure gauge consisting of an inverted glass tube, whose internal surface is covered beforehand with a preparation of chromate of silver, rendered colourless by the sea water up to the height to which it penetrates. The value of this instrument for guiding the navigator within what he calls "soundings" can hardly be exaggerated; with the sounding machine and a good chart he can generally make out his position correctly by a succession of three or four casts in a given direction at given intervals, and thus in foggy weather is made independent of astronomical observations and of the sight of lighthouses or the shore. By the proper use of this apparatus, such accidents as happened to the mail steamer "Mosel" not a fortnight ago would not be possible. As regards the value of the deep-sea instrument I can speak from personal experience, as on one occasion it enabled those in charge of the cable ss. "Faraday" to find the end of an Atlantic cable, which had parted in a gale of wind, with no other indication of the locality than a single sounding, giving a depth of 950 fathoms. To recover the cable a number of soundings in the supposed neighbourhood of the broken end were taken, the 950 fathom contour line was then traced upon a chart, and the vessel thereupon trailed its grapnel two miles to the eastward of this line, when it soon engaged the cable 20 miles away from the point, where dead reckoning had placed the ruptured end.

Whether or not it will ever be practicable to determine oceanic depths without a sounding line, by means of an instrument based upon gravimetric differences, remains to be seen. Hitherto the indications obtained by such an instrument have been encouraging, but its delicacy has been such as to unfit it for ordinary use on board a ship when rolling.

The time allowed me for addressing you on this occasion is wholly insufficient to do justice to the great engineering works of the present day, and I must, therefore, limit myself to making a short allusion to a few only of the more remarkable enterprises.

The great success, both technically and commercially, of the Suez Canal, has stimulated M. de Lesseps to undertake a similar work of even more gigantic proportions—namely, the piercing of the Isthmus of Panama by a ship canal, 40 miles long, 50 yards wide on the surface, and 20 yards at the bottom, upon a dead level from sea to sea. The estimated cost of this work is £20,000,000, and more than this sum having been subscribed, it appears unlikely that political or climatic difficulties will stop M. de Lesseps in its speedy accomplishment. Through it China, Japan, and the whole of the Pacific Ocean will be brought to half their present distance, as measured by the length of voyage, and an impulse to navigation and to progress will thus be given which it will be difficult to over estimate.

Side by side with this gigantic work Captain Eads, the successful improver of the Mississippi navigation, intends to erect his ship railway, to take the largest vessels, fully laden and equipped, from sea to sea, over a gigantic railway across the Isthmus of Tehuantepec, a distance of 95 miles. Mr. Barnaby, the chief constructor of the navy, and Mr. John Fowler have expressed a favourable opinion regarding this enterprise, and it is to be hoped that both the canal and the ship railway will be accomplished, as it may be safely anticipated that the traffic will be amply sufficient to support both these undertakings.

Whether or not M. de Lesseps will be successful also in carrying into effect the third great enterprise with which his name has been prominently connected, the flooding of the Tunis-Algerian Chotts, thereby re-establishing the Lake Tritonis of the ancients, with its verdure-clad shores, is a question which could only be decided upon the evidence of accurate surveys; but the beneficial influence of a large sheet of water within the African desert could hardly be matter of doubt.

It is with a feeling not unmixed with regret that I have to record the completion of a new Eddystone lighthouse in substitution for the *chef-dœuvre* of engineering, erected by John Smeaton more than 100 years ago. The condemnation of that structure was not, however, the consequence of any fault of construction, but was caused by inroads of the sea upon the rock supporting it. The new lighthouse, designed and executed by Mr., now Sir, James Douglass, engineer of Trinity House, has been erected in the incredibly short time of less than two years, and bids fair to be worthy of its famed predecessor. Its height above high water is 130 feet, as compared with 72 feet, the height of Telford's structure, which gives its powerful light a considerably increased range. The system, originally suggested by Sir William Thomson some years ago, of distinguishing one light from another by flashes following at varied intervals has been adopted by the Elder Brethren in this as in other recent lights in the modified form introduced by Dr. John Hopkinson, in which the principle is applied to revolving lights, so as to obtain a greater amount of light in the flash.

The geological difficulties which for some time threatened the accomplishment of the St. Gothard Tunnel have been happily overcome, and this second and most important sub-Alpine thoroughfare now connects the Italian railway system with that of Switzerland and the south of Germany, whereby Genoa will be constituted the shipping port for those parts.

Whether we shall be able to connect the English with the French railway system by means of a tunnel below the English Channel is a question that appears dependent at this moment rather upon military and political than technical and financial considerations. The occurrence of a stratum of impervious grey chalk at a convenient depth below the bed of the Channel minimises the engineering difficulties in the way, and must influence the financial question involved. The protest lately raised against its accomplishment can hardly be looked upon as a public verdict; but seems to be the result of a natural desire to pause pending the institution of careful inquiries. These inquiries have been made by a royal scientific commission, and will be referred for further consideration to a mixed parliamentary committee, upon whose report it must depend whether the natural spirit of commercial enterprise has to yield in this instance to political and military considerations. Whether the Channel Tunnel is constructed or not, the plan proposed some years ago by Mr. John Fowler of connecting England and France

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by means of a ferry boat capable of taking railway trains would be a desideratum justified by the ever-increasing intercommunication between this and Continental countries.

The public inconvenience arising through the obstruction to traffic by a sheet of water is well illustrated by the circumstance that both the estuaries of the Severn and of the Mersey are being undermined in order to connect the railway systems on the two sides, and that the Frith of Forth is about to be spanned by a bridge exceeding in grandeur anything as yet attempted by the engineer. The roadway of this bridge will stand 150 feet above high-water mark, and its two principal spans will measure a third of a statute mile each. Messrs. Fowler and Baker, the engineers to whom this great work has been entrusted, could hardly have accomplished their task without having recourse to steel for their material of construction, nor need the steel used be of the extra mild quality particularly applicable for naval structures to withstand collision, for, when such extreme toughness is not required, steel of very homogeneous quality can be produced, bearing a tensile strain double that of iron.

The tensile strength of steel, as is well known, is the result of an admixture of carbon with the iron, varying between $\frac{1}{10}$th and 2 per cent., and the nature of this combination of carbon with iron is a matter of great interest both from a theoretical and practical point of view. It could not be a chemical compound which would necessitate a definite proportion, nor could a mere dissolution of the one in the other exercise such remarkable influence upon the strength and hardness of the resulting metal. A recent investigation by Mr. Abel has thrown considerable light upon this question. A definite carbide of iron is formed, it appears, soluble at high temperatures in iron, but separating upon cooling the steel gradually, and influencing only to a moderate degree the physical properties of the metal as a whole. In cooling rapidly there is no time for the carbide to separate from the iron, and the metal is thus rendered both hard and brittle. Cooling the metal gradually under the influence of great compressive force, appears to have a similar effect to rapid cooling in preventing the separation of the carbide from the metal, with this difference, that the effect is more equal throughout the mass, and that more uniform temper is likely to result.

When the British Association met at Southampton on a former occasion, Schönbein announced to the world his discovery of gun-cotton. This discovery has led the way to many valuable researches on explosives generally, in which Mr. Abel has taken a leading part. Recent investigations by him, in connection with Captain Noble, upon the explosive action of gun-cotton and gunpowder, confined in a strong chamber, which have not yet been published, deserve particular attention. They show that while by the method of investigation pursued about twenty years ago by Karolye (of exploding gunpowder in very small charges in shells confined within a large shell partially exhausted of air), the composition of the gaseous products was found to be complicated and liable to variation, the chemical metamorphosis which gun-cotton sustains, when exploded under conditions such as obtain in its practical application, is simple and very uniform. Among other interesting points noticed in this direction was the fact that, as in the case of gunpowder, the proportion of carbonic acid increases, while that of carbonic oxide diminishes with the density of the charge. The explosion of gun-cotton, whether in the form of wool or loosely spun thread, or in the packed compressed form devised by Abel, furnished practically the same results if fired under pressure—that is, under strong confinement—the conditions being favourable to the full development of its explosive force; but some marked differences in the composition of the products of metamorphosis were observed when gun-cotton was fired by detonation. With regard to the tension exerted by the products of explosion, some interesting points were observed, which introduce very considerable difficulties into the investigation of the action of fired gun-cotton. Thus, whereas no marked differences are observed in the tension developed by small charges and by very much larger charges of gunpowder having the same density (*i.e.*, occupying the same volume relatively to the entire space in which they are exploded), the reverse is the case with respect to gun-cotton. Under similar conditions in regard to density of charge, 100 grammes of gun-cotton gave a measured tension of about 20 tons on the square inch, 1,500 grammes gave a tension of about 29 tons (in several very concordant observations), while a charge of 2·5 kilos gave a pressure of about 45 tons, this being the maximum measured tension obtained with a charge of gunpowder of five times the density of the above.

The extreme violence of the explosion of gun-cotton as compared with gunpowder when fired in a closed space was a feature attended with formidable difficulties. In whatever way the charge was arranged in the firing cylinder, if it had free access to the enclosed crusher gauge, the pressures recorded by the latter were always much greater than when means were taken to prevent the wave of matter suddenly set in motion from acting directly upon the gauge. The abnormal or wave-pressures recorded at the same time that the general tension in the cylinder was measured amounted in the experiment to 42·3 tons, when the general tension was recorded at 20 tons; and in another, when the pressure was measured at 29 tons, the wave-pressure recorded was 44 tons. Measurements of the temperature of explosion of gun-cotton showed it to be about double that of the explosion of gunpowder. One of the effects observed to be produced by this sudden enormous development of heat was the covering of the inner surfaces of the steel explosion-vessel with a network of cracks, small portions of the surface being sometimes actually fractured. The explosion of charges of gun-cotton up to 2·5 kilos in perfectly closed chambers, with development of pressures approaching to 50 tons on the square inch, constitutes alone a perfectly novel feat in investigations of this class.

Messrs. Noble and Abel are also continuing their researches upon fired gunpowder, being at present occupied with an inquiry into the influence exerted upon the chemical metamorphosis and ballistic effects of fired gunpowder by variation in its composition, their attention being directed especially to the discovery of the cause of the more or less considerable erosion of the interior surface of guns produced by the exploding charge—an effect which, notwithstanding the application of devices in the building up of the charge specially directed to the preservation of the gun's bore, have become so serious that, with the enormous charges now used in our heavy guns, the erosive action on the surface of the bore produced by a single round is distinctly perceptible. As there appeared to be *primâ facie* reasons why the erosive action of powder upon the surface of the bore at the high temperatures developed should be at any rate in part due to its one component sulphur, Noble and Abel have made comparative experiments with powders of usual composition and with others in which the proportion of sulphur was considerably increased, the extent of erosive action of the products escaping from the explosion vessel under high tension being carefully determined. With small charges, a particular powder containing no sulphur was found to exert very little erosive action as compared with ordinary cannon powder; but another powder, containing the maximum proportion of sulphur tried (15 per cent.), was found equal to it under these conditions, and exerted very decidedly less erosive action than it, when larger charges were reached. Other important contributions to our knowledge of the action of fired gunpowder in guns, as well as decided improvements in the gunpowder manufactured for the very heavy ordnance of the present day, may be expected to result from a continuance of these investigations. Professor Carl Himly, of Kiel, having been engaged upon investigations of a similar nature, has lately proposed a gunpowder in which hydrocarbons precipitated from solution in naphtha take the place of the charcoal and sulphur of ordinary powder. This powder has amongst others the peculiar property of completely resisting the action of water, so that the old caution, "Keep your powder dry," may hereafter be unnecessary.

The extraordinary difference of condition, before and after its ignition, of such matter as constitutes an explosive agent, leads us up to a consideration of the aggregate state of matter under other circumstances. As early as 1776, Alexander Volta observed that the volume of glass was changed under the influence of electrification, by what he termed electrical pressure. Dr. Kerr, Govi, and others have followed up the same inquiry, which is at present continued chiefly by Dr. George Quincke, of Heidelburg, who finds that temperature, as well as chemical constitution of the dielectric under examination, exercises a determining influence upon the amount and character of the change of volume effected by electrification; that the change of volume may under certain circumstances be effected instantaneously, as in flint glass, or only slowly, as in crown glass, and that the elastic limit of both is diminished by electrification, whereas, in the case of mica and of gutta percha, an increase of elasticity takes place.

Still greater strides are being made at the present time towards a clearer perception of the condition of matter when particles are left some liberty to obey individually the forces brought to bear upon them. By the discharge of high tension electricity through tubes containing highly rarefied gases (Geissler's tubes), phenomena of discharge were produced which were at once most striking and suggestive. The Sprengel pump afforded a means of pushing the exhaustion to limits which had formerly been scarcely reached by the imagination. At each step the condition of attenuated matter revealed varying properties when acted upon by electrical discharge and magnetic force. The radiometer of Crooks imported a new feature into these inquiries, which at the present time occupy the attention of leading physicists in all countries.

The means usually employed to produce electrical discharge in vacuum tubes was Ruhmkorff's coil; but Mr. Gassiot first suc-

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ceeded in obtaining the phenomena by means of a galvanic battery of 3,000 Leclanché cells. Dr. De La Rue, in conjunction with his friend, Dr. Hugo Müller, has gone far beyond his predecessors in the production of batteries of high potential. At his lecture "On the Phenomena of Electric Discharge," delivered at the Royal Institution in January, 1881, he employed a battery of his invention consisting of 14,400 cells (14,832 volts), which gave a current of 0·054 ampere, and produced a discharge at a distance of 0·71 inch between the terminals. During last year he increased the number of cells to 15,400 (15,450 volts), and increased the current to 0·4 ampere, or eight times that of the battery he used at the Royal Institution.

With the enormous potential and perfectly steady current at his disposal, Mr. De La Rue has been able to contribute many interesting facts to the science of electricity. He has shown, for example, that the beautiful phenomena of the stratified discharge in exhausted tubes are but a modification and a magnification of those of the electric arc at ordinary atmospheric pressure. Photography was used in his experiments to record the appearance of the discharge, so as to give a degree of precision otherwise unattainable in the comparison of the phenomena. He has shown that between two points the length of the spark, provided the insulation of the battery is efficacious, is as the square of the number of cells employed. Mr. De La Rue's experiments have proved that at all pressures the discharge in gases is not a current in the ordinary acceptation of the term, but is of the nature of a disruptive discharge. Even in an apparently perfectly steady discharge in a vacuum tube, when the strata as seen in a rapidly revolving mirror are immovable, he has shown that the discharge is a pulsating one; but, of course, the period must be of a very high order.

At the Royal Institution, on the occasion of his lecture, Mr. De La Rue produced, in a very large vacuum tube, an imitation of the aurora borealis; and he has deduced from his experiments that the greatest brilliancy of aurora displays must be at an altitude of from 37 to 38 miles—a conclusion of the highest interest, and in opposition to the extravagant estimate of 281 miles at which it had been previously put.

The President of the Royal Society has made the phenomena of electrical discharge his study for several years, and resorted in his important experiments to a special source of electric power. In a note addressed to me, Dr. Spottiswoode describes the nature of his investigations much more clearly than I could venture to give them. He says:—"It had long been my opinion that the dissymmetry shown in electrical discharges through rarefied gases must be an essential element of every disruptive discharge, and that the phenomena of stratification might be regarded as magnified images of features always present, but concealed under ordinary circumstances. It was with a view to the study of this question that the researches by Moulton and myself were undertaken. The method chiefly used consisted in introducing into the circuit intermittence of a particular kind, whereby one luminous discharge was rendered sensitive to the approach of a conductor outside the tube. The application of this method enabled us to produce artificially a variety of phenomena, including that of stratification. We were thus led to a series of conclusions relating to the mechanism of the discharge, among which the following may be mentioned:—

"1. That a stria, with its attendant dark space, forms a physical unit of a striated discharge; that a striated column is an aggregate of such units formed by means of a step-by-step process; and that the negative glow is merely a localised stria, modified by local circumstances.

"2. That the origin of the luminous column is to be sought for at its negative end; that the luminosity is an expression of a demand for negative electricity; and that the dark spaces are those regions where the negative terminal, whether metallic or gaseous, is capable of exerting sufficient influence to prevent such demand.

"3. That the time occupied by electricity of either name in traversing a tube is greater than that occupied in traversing an equal length of wire, but less than that occupied by molecular streams (Crooke's radiations) in traversing the tubes. Also that, especially in high vacua, the discharge from the negative terminal exhibits a durational character not found at the positive.

"4. That the brilliancy of the light with so little heat may be due in part to brevity in the duration of the discharge; and that for action so rapid as that of individual discharges, the mobility of the medium may may count as nothing; and that for these infinitesimal periods of time gas may itself be as rigid and as brittle as glass.

"5. That striæ are not merely loci in which electrical is converted into luminous energy, but are actual aggregations of matter.

"This last conclusion was based mainly upon experiments made with an induction coil excited in a new way—viz., directly by an alternating machine, without the intervention of a commutator or condenser. This mode of excitement promises to be one of great importance in spectroscopic work, as well as in the study of the discharge in a magnetic field, partly on account of the simplification which it permits in the construction of induction coils, but mainly on account of the very great increase of strength in the secondary currents to which it gives rise."

These investigations assume additional importance when we view them in connection with solar—I may even say stellar—physics, for evidence is augmenting in favour of the view that interstellar space is not empty, but is filled with highly attenuated matter of a nature such as may be put into our vacuum tubes. Nor can the matter occupying stellar space be said any longer to be beyond our reach for chemical and physical test. The spectroscope has already thrown a flood of light upon the chemical constitution and physical condition of the sun, the stars, the comets, and the far distant nebulæ, which have yielded spectroscopic photographs under the skilful management of Dr. Huggins, and Dr. Draper of New York. Armed with greatly improved apparatus the physical astronomer has been able to reap a rich harvest of scientific information during the short periods of the last two solar eclipses; that of 1879, visible in America, and that of May last, observed in Egypt by Lockyer, Schuster, and by continental observers of high standing. The result of this last eclipse expedition has been summed up as follows:—"Different temperature levels have been discovered in the solar atmosphere; the constitution of the corona has now the possibility of being determined, and it is proved to shine with its own light. A suspicion has been aroused once more as to the existence of a lunar atmosphere, and the position of an important line has been discovered. Hydro-carbons do not exist close to the sun, but may in space between us and it."

To me personally these reported results possess peculiar interest, for in March last I ventured to bring before the Royal Society a speculation regarding the conservation of solar energy, which was based upon the three following postulates, viz.:—

1. That aqueous vapour and carbon compounds are present in stellar or interplanetary space.

2. That these gaseous compounds are capable of being dissociated by radiant solar energy while in a state of extreme attenuation.

3. That the effect of solar rotation is to draw in dissociated vapours upon the polar surfaces, and to eject them after combustion has taken place back into space equatorially.

It is, therefore, a matter of peculiar gratification to me that the results of observations here recorded give considerable support to that speculation. The luminous equatorial extensions of the sun which the American observations revealed in such a striking manner (with which I was not acquainted when writing my paper) were absent in Egypt; but the outflowing equatorial streams I suppose to exist could only be rendered visible by reflected sunlight, when mixed with dust produced by exceptional solar disturbances or by electric discharge; and the occasional appearance of such luminous extensions would serve only to disprove the hypothesis entertained by some, that they are divided planetary matter, in which case their appearance should be permanent. Professor Langley, of Pittsburg, has shown by means of his bolometer, that the solar actinic rays are absorbed chiefly in the solar instead of in the terrestrial atmosphere, and Captain Abney has found by his new photometric method that absorption due to hydro-carbons takes place somewhere between the solar and terrestrial atmosphere; in order to test this interesting result still further, he has lately taken his apparatus to the top of the Riffel with a view of diminishing the amount of terrestrial atmospheric air between it and the sun, and intends to bring a paper on this subject before Section A. Stellar space filled with such matter as hydro-carbon and aqueous vapour would establish a material continuity between the sun and his planets, and between the innumerable solar systems of which the universe is composed. If chemical action and reaction can further be admitted, we may be able to trace certain conditions of thermal dependence and maintenance, in which we may recognise principles of high perfection, applicable also to comparatively humble purposes of human life.

We shall thus find that in the great workshop of nature there are no lines of demarcation to be drawn between the most exalted speculation and commonplace practice, and that all knowledge must lead up to one great result, that of an intelligent recognition of the Creator through his works. So then, we members of the British Association and fellow workers in every branch of science may exhort one another in the words of the American bard who has so lately departed from amongst us:—

Let us then be up and doing,
With a heart for any fate;
Still achieving, still pursuing,
Learn to labour and to wait.

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SCIENCE PURE, AND APPLIED.

Not the least interesting portion of the presidential address at the British Association meeting this year is that relating to the connection between the theory and the practice of science. Not only have the means of interchanging opinions and information largely increased during the past fifty years, but the necessity for such interchange has become more apparent; in other words, the demand for scientific knowledge in the practical affairs of life during the period referred to has greatly enlarged. It is not so very long ago that, to use Dr. Siemens's own words, science was cultivated only by the few who looked upon its application to the arts and manufactures as almost beneath consideration. Science, like truth, was, to quote the old precept, sought and pursued for its own sake. Its votaries were content to leave the material benefits to be reaped and sold by others who, with only commercial aims in view, cared little for the advancement of science except in so far as they could turn its revelations to pecuniary account. Progress, in the opinion of Dr. Siemens, could not be rapid under such conditions as these, because the man of pure science on the one hand rarely pursued his inquiry beyond the mere enunciation of a physical or chemical principle, whilst on the other the "simple practitioner" was often at a loss how to harmonise the new knowledge with the stock of information constituting his mental capital in trade. In other words, it took a long time for the practical bearings of a new discovery to reach the understanding of the simple practitioner, and pure scientists did not go out of their way to help him.

The progress of events, more especially in quite recent years, has undoubtedly rendered theory and practice more inter-dependent than ever they have been in the past; and a still more intimate union between them, Dr. Siemens thinks, is absolutely necessary for the future. In support of this view he naturally cites the case of telegraphy, and that of the application of electricity to purposes more novel but of equally growing importance. For the development of these and other industries which were instanced, "practical knowledge has to go hand in hand with advanced science in order to accomplish the desired end."

In the main it may be granted that all this is perfectly true, so true, indeed, that it would sound almost like a mere truism had the general recognition of its truth not been so long delayed. We should ourselves be inclined to say that the connection between the modern development of pure science and applied science is not so much a necessity as an accident—if the doctrine of chance may be admitted in this relation—a fortunate accident, truly, and a quite intelligible one, but still fortuitous. We might have gone on as heretofore, with practice a long way in the rear of theory, and no apparent need for their co-operation, but for certain very practical and mundane considerations, not the least of which, perhaps, is a certain change in the attitude of scientists themselves towards those grosser motives which are supposed to actuate exclusively the simple practitioner.

Occupying the eminent position he does in the domain of applied science it was proper that the newly-elected president of the British Association should deprecate on the part of any of its purely scientific members a suspicion that he undervalued their devotion to research and their lofty superiority to utilitarianism and self-interest. But he plainly told them that it was not to such as these—the high priests of science—that we can look for our practical progress any more than we can look for it from the "rule-of-thumb" ignoramus. "It is," we quote his exact words here, "to the man of science, who also gives attention to practical questions, and to the practitioner, who devotes part of his time to the prosecution of strictly scientific investigations, that we owe the rapid progress of the present day."

As a description of fact no one, we imagine, will take exception to this categorical assertion. But when Dr. Siemens proceeds to say that not only have these two classes of persons merged more and more into one class, but that they have become or will speedily become, as we understand him to imply, "the pioneers in the domain of nature," the statement will, we think, scarcely command universal acceptance. It is certainly true that we see the men of both abstract and applied science grouping themselves together nowadays for the better prosecution of special objects, but it does not necessarily follow that these objects are always or exclusively those of pioneers in the domain of nature. They may be very deserving objects, and are undeniably useful; but for the ardent, the devoted, the disinterested, if old-fashioned, high priests of science these objects were not included—were, indeed, rigorously excluded—from the programme with which they started their career. If Dr. Siemens and the modern school can reconcile the one to the other—the self-denying study of nature for its own sake with the "pleasant and profitable" application of it for the sake, let us say, of the general public—so much the better. But the illustration, borrowed

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from ancient history, with which he concluded his argument was, perhaps, not a very happy one. If it is safe to conjecture that Archimedes refused to teach the art of constructing his powerful ballistic engines to his disciples because they had not sufficiently studied the principles involved in his contrivance, the circumstance points rather to principles than to practice standing foremost in the Greek philosopher's estimation. According to the new light and leading, a modern Archimedes would take out his patent, sell the machinery, and then reproach his pupils with being "mere practitioners."

We do not say this in disparagement of the pure science which to-day makes a market of its discoveries; for perhaps we ought to admit that in the days of Archimedes it was of more importance that students should acquire first principles than that the world should possess ballistic engines. In these days the world thinks differently, and if the scientist makes haste to gratify it nobody can particularly blame him. All that we mean to point out is that somebody has to suffer for it. Archimedes at the patent agent's, or in the board room of a new company, will be wanting in the lecture hall. He cannot give undivided attention to both. The market-place is as little in harmony with the laboratory as is the bookseller's with the study; and the man who aspires to the position of a "pioneer" in either the domain of science or of letters must cheerfully deny himself those rewards which come of joining hands with the vendor.

At the same time it must be granted that nobody will be the loser—except, perhaps, the Patent Office—by the practical inventor, whom Dr. Siemens calls the simple practitioner, gaining a little more scientific knowledge; and, in so far as the presidential address tends to encourage this desirable change, we entirely agree with it. The time which the many professional inventors spend in taking out abortive patents would be far more profitably occupied in taking lessons of the scientific few. It is in this direction, perhaps, more than in any other, that we may look for any considerable and lasting progress in the applied sciences. It would be a heavy penalty to pay for progress, however rapid it might be, if in the attainment of it we sacrificed the source of its enduring strength, namely, the undivided and disinterested devotion of professional scientists.

MEASURING INSTRUMENTS USED IN ELECTRIC LIGHTING AND TRANSMISSION OF POWER.*

BY PROFESSORS W. E. AYRTON, F.R.S., AND JOHN PERRY, M.E.

During the last two years an enormous impetus has been given to the development of the electric light and electric transmission of power; and, as accurate measurements form the basis of commercial success in this as in any other branch of engineering, we hope you may not find it too tedious listening to a short description of the details of certain instruments that we have devised and have had constructed for making accurately, and at the same time quickly, the measurements that are necessary to be made, in order that an estimate may be formed of the commercial success of any special system of electric lighting or transmission of power.

After the most charming paper given us at our last meeting by Mr. Stroh, and of which the recollection must for a long time remain in all our minds, we feel that some apology is due to you for the rather prosy production which to-night follows it.

The chief objection to instruments used in measuring strong currents is that, first, the deflections are not proportional to the current, and, secondly, there is no easy method of calibrating the instrument—that is, ascertaining the strength of the current that is necessary to produce any given deflection. At the end of 1880, we tried in our "illuminator," used in connection with our apparatus for seeing by electricity, a method that has since been described by MM. Deprez and Carpentier, for making the deflection proportional to the current. This consisted in placing the axis of the coil, not, as is usual in galvanometers, at right angles to the axis of the permanent magnetic field, but at an acute angle with it, so that, instead of, as is usually the case in ordinary galvanometers, the magnetic moment due to the current diminishing as the needle is deflected, while that due to the permanent controlling field increases, and in consequence of which the current must increase much more rapidly than the deflection, our plan of sloping the coil causes the magnetic moment due to the currents to increase up to a certain point. But in our later instruments, indeed in all instruments with permanent magnetic fields that we have made since the commencement of 1881, we have abandoned this method in favour of giving to the coil, needle, and pole-pieces exactly the shape that theory shows to be necessary to obtain deflections exactly proportional to the current.

1. *Commutator Ammeter.*

Last year we had the honour of bringing before the Society an instrument by means of which strong electric light currents can be measured, and yet which can be calibrated by the employment of a single Daniell cell. This instrument, which we have since called an "ammeter," short for amperemeter, contains, as the members will remember, a coil consisting of ten strands, each of exactly the same resistance. These ten strands, by means of a simple commutator, can be joined either in series or in parallel circuit, and so the sensibility of the instrument can be increased exactly ten times without altering the dead-beat character of the instrument, which latter is produced by the extreme lightness of the needle and corrugated aluminium pointer and by the great strength of the magnetic field.

To calibrate the ammeter, the commutator is turned to series, and a current sent through the instrument by a cell of known electromotive force, E, but of unknown resistance, producing, say, a deflection, D_1; the plug attached to the instrument is now taken out, which has the effect of adding a resistance of one ohm to the circuit, and a second deflection, D_2, obtained. From this it can easily be shown that a current of $10 \frac{D_1 - D_2}{D_1 D_2} E$ amperes will produce 10deg. deflection when the commutator is in series, or 1deg. deflection when the commutator is to parallel.

Many of the instruments are adjusted to give 1 ampere per degree when the commutator is to parallel; others, again, are arranged to give 2 amperes per degree; while some go as high as 5 amperes per degree, and therefore measure currents of over 200 amperes.

In designing this commutator ammeter, we originally only thought of using the high grade of sensibility for the purpose of calibrating the instrument, but we have since found it extremely convenient when testing the comparatively small currents of 0·5 to 2 amperes used with incandescent lamps.

2. *Commutator Voltmeter.*

Since the reading of that paper, we have constructed a commutator voltmeter on much the same principle, but in this case each coil has a resistance of 40 ohms, so that when in series the instrument has 400 ohms resistance, and when parallel only 4 ohms, whereas in the ammeter the resistance in series is about 0·3 ohm and parallel 0·005, the latter being more than one-hundredth of the former, in consequence of the resistance of the small leading wires inside the instruments.* The ammeter is calibrated in series and generally used in parallel circuit, whereas the voltmeter is calibrated in parallel circuit and used generally in series, and indicates from 1 volt per degree in some

* A Paper read before the Society of Telegraph Engineers and of Electricians.

* The voltmeters are now made with each coil having a resistance of 200 ohms, so that the instrument in series has a resistance of 2,000 ohms, and in parallel circuit, 20 ohms, the resistance coil being also of 20 ohms.

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instruments to 5 volts per degree in others, the total deflection of 45deg. in the latter case corresponding with 225 volts. But just as the ammeter can be conveniently used in series, when testing the comparatively small currents passing through a single incandescent lamp, so the voltmeter may be used in parallel circuit for testing electromotive forces of two or three volts, such as, for example, the electromotive forces of one or two Faure accumulators. To calibrate the voltmeter, the commutator is turned to *parallel*, and a current sent through the instrument by a cell of known electromotive force, E, but of unknown resistance, producing, say, a deflection of D_1; the plug attached to the instrument is now taken out, which has the effect of adding a resistance of 4 ohms, and a second deflection, D_2, obtained. From this it can easily be proved that an electromotive force $10\frac{D_1 - D_2}{D_1 D_2}E$ volts between the terminals of the instrument will produce a deflection of 10deg. when the commutator is to parallel, or 1deg. when to series.

In the ammeter the resistance coil can be introduced in the circuit *only* when the commutator is to series, and in the voltmeter *only* when to parallel, so that in neither case can it be fused by the plug being accidentally taken or left out when a strong current, or, in the second case, a large electromotive force, is being measured. And more than this, to avoid the coils of the instrument itself being fused, or the needle being damaged by the instruments being arranged

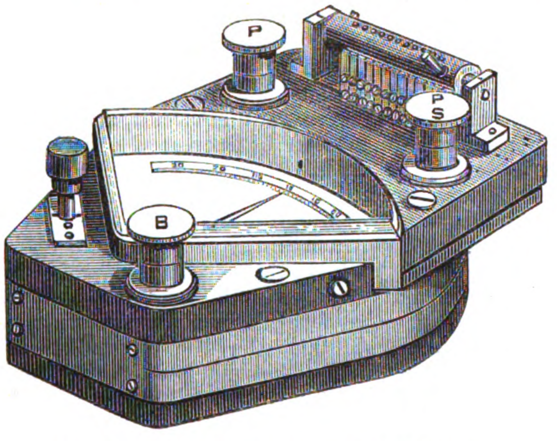

FIG. 1.—Commutator Ammeter and Voltmeter.

for maximum sensibility when currents or electromotive forces suitable for the $\frac{1}{10}$ sensibility of the instrument are being measured, each instrument is provided with three binding screws marked respectively B, (PS), and P, as seen in Fig. 1. In all the newer ammeters the screw P is suitable for a thick wire, and B only for a thin, (PS) being suitable for either. Hence the wires from a dynamo, for example, can only be attached to (PS) and P, and not possibly to B. Now, a current can only pass through the instrument from (PS) to (P) when the commutator is to parallel. Hence, if accidentally left to series, the circuit is merely interrupted, instead of the coils being fused, or the pointer damaged by too large a deflection. Precautions of a similar kind are also taken in the construction of the voltmeter, by the use of three distinct binding screws on the instrument.

All the instruments are so wound that, when a current is sent from binding screw to binding screw, at each side of the commutator, the pointer points to that binding screw at which the positive current enters.

3. *Non-Commutator Ammeter and Voltmeter.*

In electric light factories or other places where many ammaters or voltmeters are employed, it is, of course, unnecessary that all should be provided with commutators for easy independent calibration. It is sufficient that a few of the ammeters and voltmeters should have commntators for independent calibration; the remainder, which in that case are made as shown in Fig. 3, being calibrated by direct comparison with the commutator ones.

In all our instruments the needle and pointer are pivoted by an axis passing through their common centre of gravity, so that the deflection is unaltered, no matter in what position the instrument be held, and, the pivot resting in jewels top and bottom, the friction is also practically unaltered by turning the instrument on its side or holding it upright. The permanent attached magnet is also so strong that the ammeters or voltmeters may be placed not very far from even a dynamo machine in action, without the magnetism of the machine affecting the indication of the instruments.

One difficulty, however, has practically arisen in the use of these instruments, and that is, although the special mode of winding adopted, combined with the existence of the commutator, enables any one by means of a single good Daniell cell to calibrate his instrument for himself, practically Daniell cells do not exist at many places where there are electric light installations, and consequently people do not calibrate their instruments for themselves, and so do not detect the charges of magnetism in the permanent magnets which necessarily occur, and against which the user is warned by a notice stuck in the lid of the box accompanying every ammeter or voltmeter.

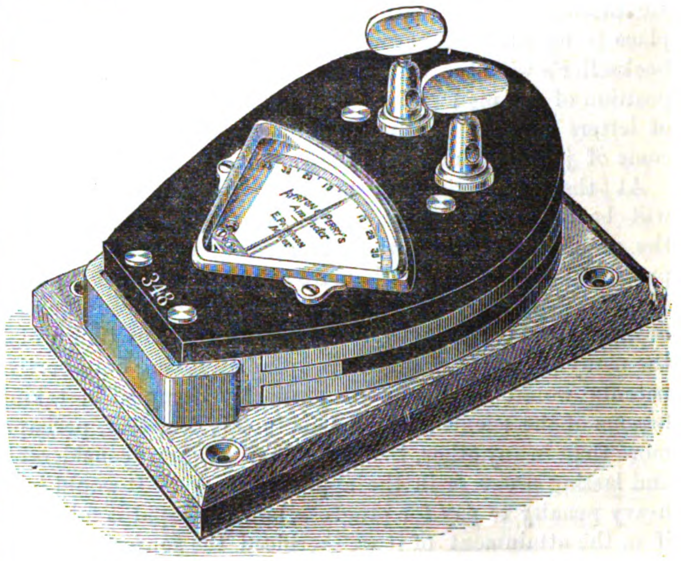

FIG. 2.—Non-commutator Ammeter and Voltmeter.

To partially avoid the loss of magnetism in the controlling permanent magnets, an armature ,seen in the last figure, is supplied with each instrument, but which, of course, must be removed when the instrument is in use.

4. *Spring Ammeter and Voltmeter.*

To, however, completely overcome this difficulty of loss of magnetism in the permanent magnets, we have decided to abandon permanent controlling magnets, and so we have constructed ammeters and voltmeters like those shown in Fig. 3, and in which the controlling force is that of either a flat or a cylindrical spiral spring, A, the axis of the soft iron needle in this case making an angle less than a right angle with the axis of the coil when no current is passing, since if it made a right angle it would be in unstable equilibrium when a current passed. The best angle that the axis of the needle should make with the axis of the coil when the pointer points to nought we have determined partly by calculation and partly by a long course of experiments, and we find that, with a proper initial adjustment, we can obtain deflections of the pointer up to 45deg. *directly* proportional to the current.

These instruments possess two important advantages not possessed by any of our earlier forms—the one being that they can be used with reverse currents; the second, that by giving any special set to the spring (for doing which there is a small hand seen in the figure, and which can be turned through any angle indicated by a small graduated scale, A, under it),

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the needle does not start from the zero position until the current in the ammeter or electromotive force in the voltmeter exceeds a certain prearranged limit. This method of giving a set to the spring greatly increases the sensibility of the instrument. Suppose, for example, currents of about 30 amperes, or currents varying, say from 25 to 35 amperes, are to be measured with a special instrument, then, instead of the pointer starting from nought for even a small current, a set is given to the spring, so that the pointer does not leave the zero until a current of 25 amperes traverses the coils. In the former case the spring would have to be so strong that the total possible deflection (45deg.) was produced by the 35 amperes—that is, about 1·3deg. per ampere; whereas, in the latter case, a weaker spring set-up would be used, such as to be deflected through the 45deg. for an addition of 10 amperes to the 25 necessary to start the pointer. In the latter case we should have 4deg. per ampere, or a sensibility about three times as great as before.

Spring voltmetres on a similar principle we have also had made.

5. *Wheel and Pinion Ammeter and Voltmeter.*

Where still greater delicacy is required, the form of the instrument is somewhat changed. Attached to the arbor of the needle is a wheel, W (Fig. 4), with very finely cut teeth

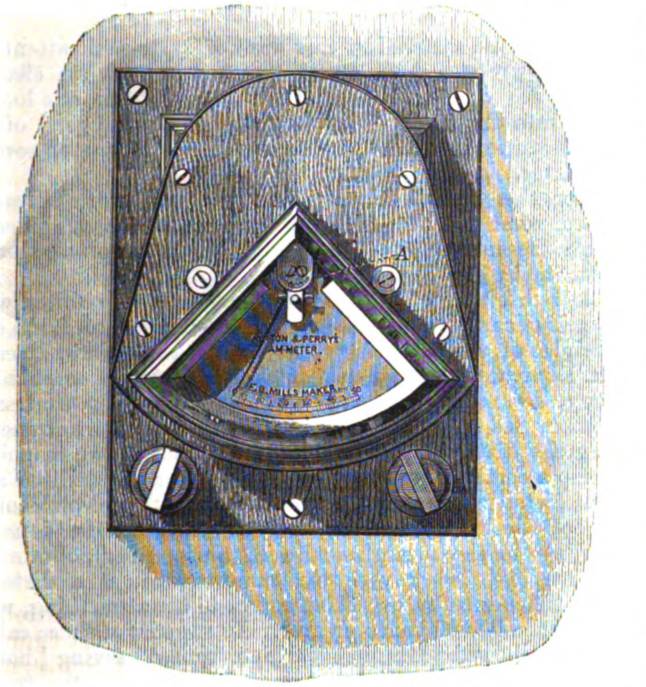

Fig. 3.—Spring Ammeter and Voltmeter.

gearing into those of a pinion, P, on the arbor to which the pointer is attached. With this arrangement the motion of the pointer is magnified ten times. If, then, the coil and needle have such a shape, and the axis of the needle makes such a proper initial angle with the axis of the coil that the deflection of the needle up to not more than even 36deg. is proportional to the current, then with our wheel and pinion arrangement the deflection of the pointer over the entire scale of 360deg. will be proportional to the current. In addition to these, both the arbor of the needle as well as the arbor of the pinion are provided with very delicate cylindrical spiral springs, S S′, one or both of which may be employed, since the latter can be thrown out of gear by raising the arm, A, which is done by turning the head, H, of the adjusting screw. If both the springs be of the same strength, then the sensibility of the instrument can be instantly made exactly one hundred times as great by turning the milled head H, which raises the arm A, and throws S′ out of gear, or can be increased to any other known less or greater pre-arranged amount, by having the spring on the pinion weaker or stronger than that on the wheel.

Both springs have, further, little hands, *h*, *h′* (seen in the figure), for setting them up, so that the whole deflection of 360deg. may, if desired, be produced by a small percentage of change in the total current when it is wished to measure accurately small changes in a fairly constant current. The wheel and pinion ammeter, then, furnishes an instrument for the measurement of strong currents comparable in delicacy with the instruments usually employed for the measurement of only weak currents. Every bearing is jewelled as it is in a good watch, hence the freedom of motion is very great.

An ammeter on this principle we are now constructing to measure up to 1,200 amperes.

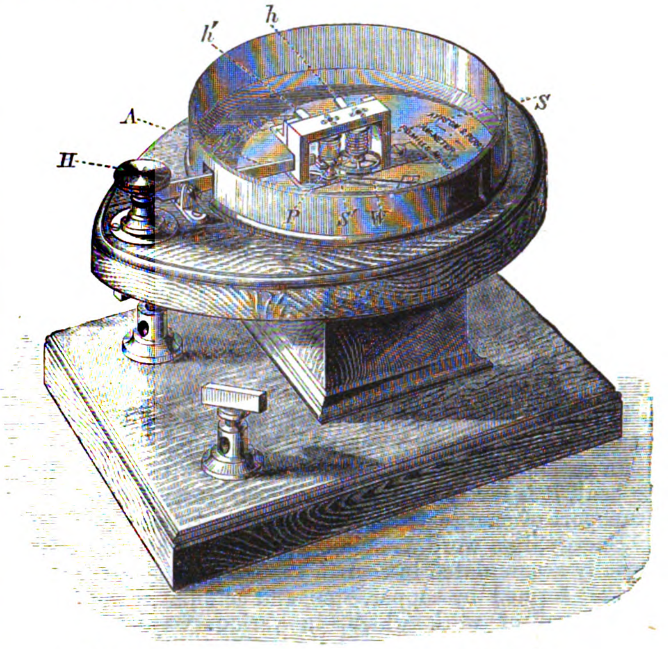

Fig. 4.—Wheel and Pinion Ammeter and Voltmeter.

On a similar principle, we have constructed wheel and pinion voltmeters, with two grades of sensibility, for measuring electromotive forces with great accuracy.

By means of simultaneous measurements of the currents flowing through a circuit, and the difference of potentials between its two ends, the horse-power electrically given to that circuit can be ascertained, since this horse-power equals $A \times V \times \cdot 00134$, where A is the current in amperes and V the difference of potentials in volts; also $A \times V \times 44 \cdot 25$ equals the number of foot pounds of work per minute electrically given to that part of the circuit.

(TO BE CONTINUED.)

ELECTRICAL MEASUREMENTS AND MACHINES.*

M. Deprez began with a very interesting elementary account of the measurement of currents, and the principal laws which govern them. He took the voltameter as a guide, and explained Faraday's law. The quantities of gas disengaged in the voltameter and those of metal dissolved in the liquids of each cell of the battery are in the ratio of the equivalents of these bodies.

M. Deprez showed us the voltameter becoming, in the hands of Grove, a gas battery and an accumulator, according to the current expression of the day. This new battery is capable of decomposing water in a voltameter, supposing, of course, that several gas cells are employed. And, lastly, this experiment obeys the law of Faraday, that is to say, that the quantity of gas combined in each active voltameter is equal to that disengaged in each passive voltameter. Strictly speaking, there is no chemical action really passive; the voltameter, in the usual acceptation of the word, has its

* A lecture delivered by M. Marcel Deprez at the Conservatoire des Arts et Métiers, June 15th, 1882. Translated from *L'Electricien*.

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active force, its reaction, and its electromotive force, which still exists after the current is broken.

We next come to Joule's labours, and the law which he made known respecting the production of heat by electricity. Every wire traversed by a current is heated, and radiates a part of the heat thus produced. If there were no radiation, the wire, even though traversed by a weak current, would rapidly reach the temperature of fusion.

Joule's law may be expressed by different formulæ, thus :—

C = the quantity of heat developed during the whole circuit,
R = the total resistance of the circuit,
I = the intensity of the current,
E = the electromotive force of the source of electricity ;

then $$C = RI^2 = \frac{E^2}{R} = E\,I.$$

If we consider a given section of the circuit :—

C′ = the quantity of heat developed in it,
r = the resistance of the given section,
e = the difference of potential between the two extremities of the section,
I = the intensity which does not change ;

then we get $$C' = r\,I^2 = \frac{e^2}{r} = e\,I.$$

These formulæ regulate the transport of heat by a source of electricity to a given point of the circuit.

In reality the application of these formulæ is not limited to heat, it is far more general. These formulæ regulate the transport of energy or its transformation in any case.

Energy, in a word, is stored up work. Chemical energy is usually accumulated in certain groups of bodies, for instance in that formed by copper, zinc, and acidulated water. Heat is a form of work which, in various ways, may furnish mechanical work or chemical work. Mechanical work, indeed, is stored up under every form ; *e.g.*, a heavy body raised to a height of one metre from the ground has stored-up, in rising, mechanical work ; if it fall to the ground without any obstacle, this work reappears in the form of heat, and in the form of vibratory motion, which is itself resolved into heat.

We pass next to the theory of motors, and especially to the study of the transport of mechanical force between two electrical machines connected together.

In the first place M. Deprez shows us, in the receiver of electricity or electric-motor, an electromotive force of induction or reaction exactly comparable with polarisation in a voltameter. We find once more the formula of the work T expended by the generator, and of the work t available for the motor.

E = the electromotive force of the generator or source,
e = the inverse electromotive force of the receiver,
I = the intensity in amperes,
R = the total resistance of the circuit,
K = the electrical return or result.

Then
$$T = E\,I.$$
$$t = e\,I.$$
$$I = \frac{E-e}{R}.$$

The result is the ratio of the work of the motor which can be utilised to the work of the generator which is expended.

$$K = \frac{t}{T} = \frac{e\,I}{E\,I} = \frac{e}{E}.$$

We get from these formulæ :—

$$T = E\,I = \frac{E\,(E-e)}{R} = \frac{E^2\left(1-\frac{e}{E}\right)}{R} = \frac{E^2\,(1-K)}{R}.$$

This formula shows that if we wish to keep K T and t constant, when R increases, we must increase E, so as to keep $\frac{E^2}{R}$ constant, that is to say, that E must increase as $\sqrt{R}$, or as the square root of the resistance of the circuit.

The lecturer then proceeded to give the history of electro-motors. At first those who looked into the subject had been struck with the great attractive force of electro-magnets at a short distance, losing sight somewhat of the fact that work is the product of force and the space traversed, and that this latter factor was wanting. They thought they could replace the distance lacking by the rapid repetition of a short movement ; they admitted implicitly that the magnetism and demagnetisation of the electro-magnet, under the rapid influence of the openings and closings of the current, were instantaneous, whilst, on the contrary, magnetisation takes a very considerable time, and demagnetisation a much longer time, without ever reaching completion. New difficulties were met with. Numbers of electro-motors were invented and constructed, treasures of ingenuity were expended during twenty years at least, and all without any result.

The erroneous idea which we have just mentioned was not the only difficulty which stood in the way of the inventors of that time ; the battery was the only source of electricity they were acquainted with, and we know that the substance consumed in the battery is zinc, the price of which is comparatively high.

Continued want of success opened men's eyes, and those who were in some measure familiar with the subject at length considered the problem insoluble, and paid no further attention to the new electro-motors, which were still making their appearance.

M. Pacinotti suffered by this want of systematic attention, when he wrote a short descriptive account of an electro-motor. No one paid any attention to it ; no one looked deeply into the paper, in which, however, lay the germ of the great movement which the Gramme machine started several years later.

After this period of oblivion for the problem of electro-motors, some clear-sighted intellects hit upon the idea of solving the inverse problem—viz., that of the production of electricity by electrical machines.

The Exhibition of 1867 made the public acquainted with the self-generating machines of Siemens and of Ladd, the principles of which will always be utilised in certain cases.

M. Deprez passed on next to the transport of mechanical energy, by means of two electrical machines connected together. He treated the question of the transport of energy at a great distance, and demonstrated that if two machines develop a certain amount of work which may be utilised at a short distance, we may, by multiplying the electromotive force of the two machines by 100 (which can be done by fastening to the machines wire 10 times finer), obtain the same available work with the same return, at a distance 10,000 times greater, or, which comes to the same thing, with a resistance 10,000 times greater. In support of these calculations he showed a Gramme machine (type A) giving ½ horse-power, with an electrical return of 70 per cent. ; the resistance of the circuit was 500 ohms, or equal to 50 kilometres of iron wire of four millimetres, or ordinary telegraph wire ; the electromotive force of the generator was 2,400 volts, and and the intensity of the current 1·6 ampere.

Here (quoting M. Sarcia) are some interesting figures :—

Speed of generator	1,530 revs. per min.
Speed of receiver	1,110 „ „
Ratio of speeds or " rendement " ...	72 per cent.
Resis. of each of the two machines	465 ohms.

The lecturer had not time enough at his disposal to explain his theory of distribution, much to the regret of his audience ; the experiment in distribution which he made with three Gramme machines, one Siemens, and a new machine (an electric hammer), was intended to show that each motor is independent of the motion or rest of the others. One motor was stopped, and the other machines showed no appreciable difference in the work done.

The electric hammer is a very curious machine, which raises an iron cylinder of 25 kilogrammes to a height of 1 metre, by means of a special solenoid. It can be let fall at will by breaking the circuit.

M. Deprez interested us with some calculations he had made as to machines *without iron*, as the calculation is not available in the case of machines containing iron. These re-

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searches prove that if a machine of this kind be doubled in dimensions, the volume and the weight becoming eight times greater, the force becomes 16 times greater. He showed us two machines, each composed of a flat movable coil and without iron, between two similar fixed ones. The second had dimensions double those of the first, and the distance between the movable coil and the fixed ones was also double.

The weights of the two movable coils were then in the ratio of eight; the attractive force was 16 times greater for the second than for the first, the intensity of the current being the same in both.

Another apparatus, which was not shown, and in which the coils have iron cores, gave a ratio of 15 for the attractive force. The forces were, undoubtedly, much greater than in the case of coils without wire; but the ratio of the forces was less—a very interesting result, though one which might be expected.

This experiment would suffice to prove that there is a great advantage in making large machines. As M. Deprez puts it, "L'Avenir est aux grandes machines."

CORRESPONDENCE.

FIRE RISKS FROM ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In my letter in reply to "Electric Light" I said I had more to say about the new rules issued by the Society of Telegraph Engineers and Electricians if no one else came forward in the matter.

Your foot note at the end of my letter is either a challenge or an invitation for me to "prove my condemnation justifiable."

Well, I thought I had produced sufficient justification in the course of my criticism, but I will now endeavour to follow up my attack fairly and fearlessly.

In my explanation of the "rules" I find the four following propositions:

1st. That the present methods of insulation of wires are proved by the committee's own words to be very faulty.

2nd. This faulty insulation is assumed by them to be the great and obstinate difficulty in electric lighting, because they neither specify nor give hopes of any remedy, but only insist that the evils may be detected as they break out by testing with "delicate apparatus," for which some degree of training is necessary.

3rd. "Safety Fuses" being described as the "essence of safety" which cannot be made to operate at less than 200 deg. F. Each time the contemplated catastrophe occurred the lights would be extinguished, and the insulating material, if gutta percha or ordinary compound, would be melted off, or, in most cases, greatly deteriorated.

4th. Under some circumstances the committee allow that a portion of the circuit may be non-metallic.

I must ask you to refrain from exercising your judgment at present as to whether these four propositions embrace all the practical ideas enforced in the rules, or whether it is the most correct and profitable summary of the most debatable topics therein contained. My object is not only to show that the rules in question are not serviceable, but also that they exhibit great crudity of idea on the part of those who are assumed to be authorities in the matter. And in doing so I have to place my own knowledge and opinions in antagonism with some of the best authorities on electrical subjects. If I am right, and were to hold my peace, it seems likely that electric lighting would go on on such a self-extinguishing system that it would scarcely survive after two or three years' further trial. This I will prove to be not my opinion only, but the natural inference from the facts endorsed and opinions enforced in the "rules."

Some electricians, high up in the scale of attainments and fame, have much to learn and much to unlearn before they can look aright upon the details involved in this matter. Let me, therefore, assure all the rest of my readers that, although much of what I have yet to say may seem like mere incidental talk, it will be distinctly addressed to their varied bias and prejudices, and what is meaningless to some may clear up doubts in others.

It is exceedingly difficult, if not impossible, to elucidate the most important practical problem involved in the rules under examination without dwelling rather elaborately on what many may think unimportant details.

If the committee had taken more trouble to set out in their code of rules what they promised in the first sentence of their preamble their joint reputation and authority might have silenced, if not convinced, the unbelieving. But my position is different, and some may think isolated. Therefore, part of my endeavours must take the form of earnest reasoning as to why I am entitled to protest so strongly as I have done against the rules in question, and why you will not be disappointed if you follow me carefully to the end. There is a common saying, which many mere science-crammed theorists would apply to the question of insulation, viz.: "It is all in a nutshell," and Rule 15 seems a mere echo of the same idea.

But there is no hope for electric lighting getting firmly established in a few years unless perfect insulation is insisted on, literally as the *sine qua non*, and practical, perfect insulation is no nutshell dogma.

Eighteen years ago I commenced fitting up electric bells. Three years later I established a business entirely confined to that branch of electricity, and I was from the commencement forcibly impressed with the necessity of securing the best possible insulation of at least the positive wire. What was the best material? and how to get men to fix the insulated wires with careful skill? were the two great questions to be settled. It was not long before I settled once for all to have very little to do with gutta percha, and still less with telegraph men. The reasons were emphatically cogent, as you will see. At that time gutta percha was the "be all and end all" as an indoor wire insulator, and with few exceptions so it remains with telegraphists to the present day.

Now, consider for a moment what is the nature of gutta percha, and what is expected of it as an efficient insulator. The best and purest gutta percha that can be bought "for love or money" shrinks if it remains in dry air, and the covering on a wire exposed to dry air for one or two years will be found full of cracks, when the gutta percha secures no better insulation than so much tarred hemp. Now, this being the case, how is it that it is so much used in telegraphy?

The reason is that in some places where the insulated wires lead in from the open air they are exposed to rain and damp, which, if constant, gutta percha would be proof against, and where it is completely buried underground it remains almost uninjured for many years. We must consider, also, that in telegraphy along bare wires, supported on poles, there is always more or less loss of current in wet weather, the occasional loss of current through impoverished gutta percha covered wires, is scarcely noticed, and the battery currents used are so comparatively feeble that the wires last a long time after the gutta percha covering has become useless.

Then, again, the current is in the wires only so long as messages are actually passing, which even then is intermittent, with, at least, as much rest as contact. In fact, a calculation on any reasonable basis would show that, taking the average use of public telegraph lines, the current is not actually passing through the wires in the aggregate more than two hours in the twenty-four.

Now, compare the state of things involved in a building where a similar amount of battery power is used to ring electric bells, &c. Here the battery current is constantly in the wire leading to every part of the building where such bells are connected, so that if the wires are insulated in the same way as those leading into telegraph offices, the loss of current must be *twelve times greater*. Now, consider what this means where the insulating material has perished and the wires surrounded with damp or moisture.

The committee admit that "moisture leads to loss of current and to the destruction of the wire by electrolytic corro-

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sion." Now, if the electrolytic corrosion or dissolution of the wire is twelve times greater in electric bell use, it is evident that, as in other trades, such as "carpentry," "joinery," and "cabinet making," the difference in the strain or "wear and tear" requires more or less care in choice of material, different experience, and training in the operatives employed, &c., &c.

If I were to dwell on the great difference between the two branches as regards the action on the battery it would be still more evident. Let us next consider how electric light wires are affected under similar circumstances. I have said that the force of current used in telegraphy is similar in amount to that used for electric bell purposes, but the latter exposes the wires to twelve times the duration of corrosive or dissolving action. In electric lighting the force of current must be, even for 50-candle light, about fifty times that required for either of the other purposes; and taking six hours as the average time of lighting it would still leave the wires exposed to twelve times the amount of corrosive or dissolving action, or 144 *times more than in telegraphic wires.* No wonder, therefore, that, using the experience, if not under the guidance of telegraphists, the great Brush Company exhibit such a sorry failure as that quoted from the report of the one year's trial in the city of London, where *a new cable had to be substituted for one in use only a few months.*

Fourteen years ago, one of the leading telegraph engineers then as well as now, and who is or was a member of the committee who have drawn up these electric light rules, came to me (a perfect stranger) to ask me to put in order or refit two hotels that his men had done, viz., the Bath Hotel, in Piccadilly, and the Randolph Hotel at Oxford, alleging as his reason for coming to me that "his men did not seem to understand the work." Shortly after he also asked me to fit up a house just taken by Sir Daniel Gooch, then and now one of the great heads of the gutta percha interest. I was asked to use gutta percha covered wires, but declined, and gave the same reasons I have before mentioned. I was allowed to have my own way, the results in all three cases being very satisfactory.

And now, after fourteen years' further experience, gutta percha covered wire is used by nearly all telegraphists whilst abandoned by nearly all others, and the use of india rubber covered wire has increased about twentyfold.

The only sensible use for gutta percha is for submarine cables, and it will all be wanted for that purpose.

In speaking thus of gutta percha I do not assume that all electric light engineers and electricians are wedded to it as the most trustworthy insulator, but when I consider how much half-hearted expediency is fretting itself with anxious scheming in trying to find some happy compromise between gutta percha, india rubber, tarred tape, paraffin wax, &c., I know that the majority of the productions of the different makers are little better than gutta percha, some of them worse. And the committee, knowing the unsettled state of mind generally prevailing on the question, ought surely to have given some suggestions on this most important of all difficulties. For some members of the committee must know that some of the latest contrivances, such as tarred tape alternated with rubber tape, have been years ago tried against gutta percha, with the result in favour of the latter. In any further references to gutta percha, therefore, let it be understood that the same remarks may be applied to any of these *arrangements;* but I shall have to speak of pure rubber only in a different sense.

They admit the prevalence of the "invisible difficulties," the "risk," the "dangers," the "leakage," "waste of energy," "moisture," "loss of current," and "destruction of conductors." Their remedy for these evils, distinctly and emphatically described in their preamble, and enforced in rules, is a system of periodical "testing or probing with electric currents" by means of "delicate apparatus." Now surely, with this catalogue of symptoms, and this insistance of surgery, we ought to get "landed right smoothly on the Stygian shores."

Bleeding the human body is generally tabooed in these days of medical science. The question is, how will electric light conductors stand bleeding? The committee advise that, without waiting for a sudden rupture, the wires should be tested to find if they leak, and as a matter of course, if the test shows that there is a leak, or several, further "testing" or "probing" must be done to discover the leak. Indeed, it would be no use proving the fact of leakage unless the individual sources of leakage were to be found and repaired. Here alone the term "probing" fitly applies. Suppose, then, that whilst the engine and dynamo are at rest one of the periodical tests shows there is leakage somewhere. If the wire extends, say 100 yards, and it is only one leak, the act of probing through the insulation on the wire in six places will bring us within a yard of the leak, when the green-blue streak will show the exact spot. Now, if the leak is only slightly developed, the usual course would be to clear away the covering for an inch or two, and make good again with new gutta percha, and all is right again, or seems so. But suppose this has happened after the wires (gutta percha covered) have been fixed more than a year, then the great probability is that there are plenty more cracks in the covering waiting only for the condensed damp to trickle *their* way, when electrolysis will be set going the moment the dynamo starts the current.

Now comes the question about the calculation of chances. Some of our best known electricians are quick and able mathematicians, and from the columns of equations that catch the eye on turning over the pages of ephemeral electric literature one would think that all such practical queries as those now under consideration had been exhaustively analysed and resolved; but not only is such an idea untrue, but on examining some of the strings of equations on cognate problems, it is often found that some of the most important conditions are omitted altogether, causing many such calculations to be misleading. The fact is, the committee seem to have a shrewd guess that the means employed by electric light engineers are not adequate to the contingencies met with, and for want of collected data from which to judge they shunt all responsibility upon the electricians in the words of their last sentence in their preamble.

Anyhow, a rough calculation from all the known facts but unknown quantities is better than an exact calculation from half the facts and assumed quantities. Therefore, I venture from my knowledge of all the facts that creep in where electric lighting is installed to make an approximate calculation as to the value of the average life of an electric light conductor, of the kinds at present used. In speaking of leaks breaking out I assumed that the conductor had been fixed about a year. Let another year be supposed to pass, and I venture to affirm that the "testing" and "probing" process will have become a tedious and expensive business. The fitful manner in which damp will settle about and condense upon wires in places most unlikely puts out all reckoning based on any forecast of its haunts or behaviour.

I have, whilst hunting out leaks amongst wires in hot rooms and corridors, been accosted with the remark:—"You don't expect to find any damage from damp here do you?" When I have several times treated such unbeliever like one of the early Christians, and when he has thrust his hand along the wires, he has wiped off convincing tears, not always pure as the dew drop, but sometimes as green as copperas.

And why, I ask, should any thoughtful person think this extraordinary when they must have many a time, on a warm spring morning after cold, found the hand drag heavily down the sweating staircase handrail, to say nothing about the door-knobs, window-panes, and painted walls covered with beads of moisture and streams of condensed, warm, damp air. Indeed, when we ask where wires can be fixed to avoid such exposure to damp, only a small portion in the most favourable buildings can ever be named as safe from the enemy. The question next to consider, therefore, is, how long will wires of average size remain sound enough under such circumstances to conduct enough current force?

Well, if the dampness is of the intermittent nature just indicated, the wires *may* stand the wear and tear for a year or two longer if left alone, for the following reason:—In most cases the condensed damp will form its beads and trickling tears in different places, as directed by infinite minute causes, a frequent accompaniment of these accidents

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being that here and there the sweating walls are traceried with extra large streams that slowly run sometimes for days. Where they come across a flaw or crack in the insulation the attack of "electrolysis" is severe for the time, especially if a similar flaw in the return wire is found within a few inches. When the action has gone on for some time the dissolved copper and gas that is produced checks or diverts the run of the water, and minute green crystals form a powdery green-blue excrescence that clogs the electrolytic action; but from that time, by its mass and capillary attraction, any ordinary amount of damp, not enough to condense on the wall, will feed the slow corrosive action. These points of attack being constantly on the increase as the insulating covering perishes, there must come a time, from one to five or six years, when the amount of "testing or probing" necessary to keep pace with the rotting system could no longer be tolerated, and the whole length of conductor must be replaced with new. Let such an example be multiplied ten-thousandfold, when the novelty of electric lighting shall have worn off, and the nuisance of the many breakdowns remains fresh in the memory, and who will say that electric lighting can survive such an ordeal?

I do not say such an end will come to pass collectively, but many such an end will come to pass with individual instances, and it seems as if such pointed warnings as I am endeavouring to construct are absolutely necessary to prevent headlong rushes to such disaster.

I may here just mention that the committee, knowing the prevalent use of gutta percha insulation, seem to forget that the fusible metal safety fuses, which they call "the essence of safety," cannot be made to melt at less than about 200 degrees Fahr., and after once attaining nearly that degree the gutta percha would be found melted away from the whole length of wire of the same size.

I do not think it is worth while to refer in detail to any substitute for gutta percha, except india rubber. All other materials or compounds are either proved to be as perishable as gutta percha, not waterproof, or they are too little known to be trustworthy. We have, however, three other well-proved methods of insulation, which I must now explain.

1st. India rubber, pure and simple.

2nd. Bare wires on insulators, indoors as well as out.

3rd. Wires variously insulated, enclosed in tubes.

About twenty years ago a committee was appointed to ascertain what was the best material for insulating submarine cables. The investigation brought forth good proof that gutta percha was best for constant immersion in water, but for alternate exposure in air and water, whether the alternations were regular or irregular, short or long, india rubber was proved to be best. But this verdict was soon ignored, probably on account of the extensive use of vulcanised india rubber and various compounds of rubber and other material, for nothing but the pure unvulcanised rubber will retain its virtue unimpaired.

I have had by me for twenty-six years samples of pure Para rubber, mixed rubber, and slightly vulcanised rubber, but those of pure rubber are the only samples that are in perfect uninjured condition after being subject merely to the changes of atmosphere and temperature for that time. It is always easy to distinguish the pure from all the rest, and if wires are covered with it in the form of tape lapped round and round, each layer well overlapping the other, it is the best insulator for indoors yet discovered. But one covering only is not sufficient to shut out water or damp perfectly; a second covering and even a third is necessary to ensure a long length being perfectly proof, due attention being necessary to the amount of overlap, and also to the temperature and strain in the act of covering. These simple conditions of success are sadly neglected in nearly all the rubber covered wire supplied by the various makers, but all will do it if insisted upon. A covering of cotton is then necessary to afford mechanical protection to the rubber, which is further improved by saturating the whole with paraffin wax or boiled linseed oil. The latter is best, but dries slowly, for it requires to remain about six months in a cool place, as in a warm place the oil softens the rubber. With the cotton paraffin waxed a treble rubber covered wire is infinitely preferable to gutta percha covering, three times the thickness and double the expense, and in any atmosphere the rubber remains any length of time imperishable.

The only drawback is that the joints require to be very carefully made good without using much excess of rubber tape for the purpose.

One incidental advantage of using rubber for electric light wires will be that as long as the safety fuses are insisted upon as the "essence of safety," the rubber covering will keep its place and remain uninjured after exposure to 212 degrees Fahr.

In my next I will deal with bare wire insulation and metal tube insulation.—Yours, &c., W. Moseley.

MEYER'S SYSTEM FOR UNDERGROUND WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The notice contained in your issue of 29th July, respecting my permanent way for electric conductors, as explained in my pamphlet on the "Development of Electricity and the Problem of the Wires," has just come to my notice. I am obliged to you for pointing out the method by which I propose to insulate and protect wires underground according to my patent; but the gist of the pamphlet you have omitted to mention, and as it is of vast public importance I would ask you kindly to give the point publicity when your space will allow. I refer to my suggestion that all conductors, of whatever kind, in a city should be placed under one control, instead of each company being allowed to take up the streets for laying their own mains.

The actual saving secured by such a plan and the avoidance of unnecessary interruption to traffic are of sufficient importance to make it desirable that this suggestion should at least be fully discussed.—Yours, &c.,

H. R. Meyer.

B 12, Exchange-buildings, Liverpool,
28th August.

ELECTRIC LIGHT FOR BICYCLE.

TO THE EDITOR OF THE ELECTRICIAN

Sir: In answer to the letter of "Bicycle," could not a secondary Faure battery be made with thin plates rolled together so as to give the greatest surface in the smallest space to run a small Edison two-candle lamp with a reflector?—Yours, &c., W. O. Bailey.

3, Place Victor Hugo, Passy Paris, France.
August 25, 1882.

DEMANDS OF A GENERAL SYSTEM OF ELECTRIC DISTRIBUTION.*

BY F. J. SPRAGUE, U.S. NAVY.

In order to more fully understand the subject of incandescent electric lighting let us consider the requirements graphically. I hardly need to argue that the multiple arc system is preferable to the series, and is in fact the only admissible one which can have any widespread application. In Fig. 1 let M be the generator, p and p' the terminals, R, R′, R″, R‴ circuits in multiple arc or parallel circuits, in other words derivation circuits from the same terminals.

Now, it matters not what the resistance of the machine, or the number or resistance of the derived circuits, if they be connected to the same terminals, the current in any circuit will be equal to the difference of potentials at the points $p.p.'$ divided by the resistance of the circuit in question. Nor does the addition or subtraction of any number of circuits make the slightest difference in the currents flowing in the circuits already established if this difference of potentials $p-p'$ is kept constant. Consequently, the currents over the different paths will be inversely proportional to their resistance, and perfectly independent of each other. Since the external resistance diminishes with the increase in the number of the derived circuits, the whole current flow-

* A Paper read at the British Association.

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ing from the terminals will vary inversely with the external resistance. But the whole current is the current flowing through the armature. Since the internal resistance enters as a factor, although the difference of potentials at the terminals remains constant, the electromotive force of the machine does not.

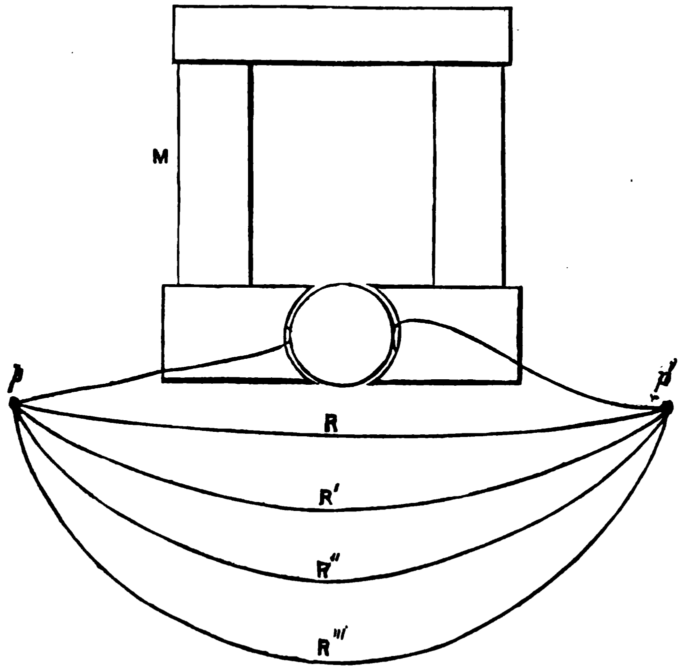

Fig. 1.

Let us consider a machine which, with an external resistance equal to the internal a, a given velocity and strength of field current, generates an electromotive force E. Call the external resistance $a\,r$, that is, some ratio, r, of the internal, and let the current in the field magnet, independent of the current generated, or the velocity, or both, be changed as the external resistance changes, so that the difference of potential at the terminals may remain constant. Consider the change in the E.M.F. of the generator. We have, then, for two external resistances, one a, equal to the internal, another $a\,r$, greater, or less, two currents,

$$C = \frac{E}{2a},$$

$$C^1 = \frac{E'}{a\,(1+r)},$$

whence $$\frac{C}{C^1} = \frac{E\,a\,(1+r)}{2\,a\,E'} = \frac{E\,(1+r)}{2\,E'}.$$

But, by conditions of working,

$$\frac{C}{C^1} = \frac{a\,r}{a} = r,$$

hence $$r = \frac{E\,(1+r)}{2\,E^1},$$

or $$E' = \frac{E\,(1+r)}{2\,r} = \frac{E}{2}\left(\frac{1}{r} + 1\right).$$

Differentiating this last equation with E as the unit of E.M.F. and E′ and r, the variable, we have

$$\frac{d\,E^1}{d\,r} = -\frac{E}{2\,r^2}$$

and $$\frac{d^2 E^1}{d\,r^2} = \frac{E}{r^3},$$

which give the character of the curve of E.M.F. under the conditions assumed. This plotted with r and E^1 as the co-ordinates x and y gives a curve with the bend near the origin, and with branches having for asymptotes the axis of y and a line parallel to the axis of x, and distant $\frac{E}{2}$ from it.

Fig. 2 gives the curve, described with the full line. Note its characteristics. Vertical lines on to the axis of x represent the E.M.F. compared with the unit E, which may be of any number of volts, and the distance from the origin the ratio of the external to the internal resistance. This curve will show some important truths, a part of them familiar, others perhaps not so, concerning the economy and practice of the distribution of electricity or the supplying of currents which will be inversely proportional to the resistance of the derived circuits, remembering meanwhile that the E.M.F. of a machine excited by a separate circuit is very nearly proportional to the strength of the free magnetic field and the velocity of the armature. Of course, this is somewhat affected by the heating of the metallic conductor for an increased current, the consequent change of resistance, the displacement of the magnetic field, and the heating of the iron part of the armature, if iron enter as a component. We notice

1st. In a single generator the E.M.F. is not proportional to the number of lights or motors or the current developed.

2nd. No matter how high the external resistance, or how limited the number of derived circuits, the E.M.F. of a machine required to maintain a fixed difference of potential at the terminals can never be less than one-half that developed when the external and internal resistances are equal.

3rd. The increase of E.M.F. required as the external resistance decreases, or the number of derived circuits is increased, is very gradual up to the point where the external resistance is three or four times the internal, beginning then to rise more rapidly.

4th. When the external resistance falls below the internal, the rise is very rapid, and if this difference is marked, then it becomes impossible to maintain a fixed difference of potential, because of the great increase necessary in the strength of the magnetic field and the velocity of the armature. A great amount of heat, and, consequently, wasted energy would be developed in the armature.

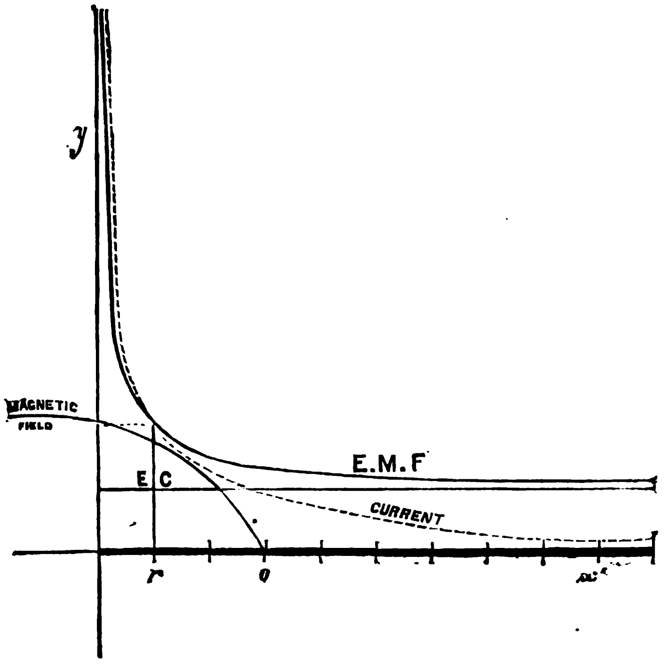

Fig. 2.

Note.—Full curve—Equation $E' = \frac{E}{2}\left(\frac{1}{r} + 1\right)$.

Dotted curve—Equation $C' = \frac{C}{2}$.

Same unit of measurement for C and E, viz., vertical from r along axis of x.

Put $r = 1, 2, 3,$ &c., and solve for C′ and E′.

Let us consider another curve. Our requirements demand that the whole current shall be inversely proportional to r, the ratio of external to internal resistance, or C being the current developed when the E.M.F. is E,

$$C^1 = \frac{C}{r}.$$

Let this curve be traced on the same axes as the preceding, and for convenience of comparison let the same unit of measure be used for C as for E. Describing the curve (see the dotted line in Fig. 2), we find it somewhat similar to the curve of E.M.F., but that it approaches both axes as asymptotes, and falls rapidly below the first curve on the right, whilst rising above it on the left. A glance shows the relations of current and electromotive force for different ratios of external and internal resistance.

Note one curve more, which I will roughly trace on the same sheet, but not with the same units. This is the curve of magnetic strength, measured here vertically, the increase of field current being measured horizontally and to the left. The strength of the magnet increases at first quite regularly; the curve, however, flattens more and more as the current increases, until at the

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point of practical economic saturation a large further increase of the field current would produce but a much smaller ratio of increase of magnetic strength. Part of the energy of the increased current would undoubtedly manifest itself in heat, both in the coils and in the iron of the magnet.

Now, in a general distribution of electricity, a large number of derivation circuits existing, there must necessarily be a low external resistance, large currents flow through the generator, and we wish to have the energy of the current in the external circuit and not in the machine. It has often been said that, the external resistance being thus reduced, the resistance of the individual lamps should be as high as possible. This is not so, for certain relations exist between the weight and resistance of carbons, the illuminating surface, the electromotive force, and current required, and the energy expended, which determine a limit. I will speak of this again.

The expression for the work done is,

$$\frac{E^2}{R} . 44{\cdot}24$$

$$\text{or } C^2 R . 44{\cdot}24.$$

Whence we see, with a given electromotive force, the work done varies inversely as the resistance, and with a given resistance the work varies as the square of the electromotive force, or the square of the current. If we increase the resistance to any ratio, d, of a given resistance, to maintain the same expenditure of force, we increase the electromotive force, but only in the ratio $\sqrt{d}$, so that with four times the resistance only twice the E.M.F. would be required. Consider, for a moment, the size and shape of the carbon. If a carbon of circular section is used, the same weight would enter in a piece of half the diameter and four times the length of a given piece, giving sixteen times the resistance and twice the illuminating surface. Thus with half the weight we can have the same surface and eight times the resistance. If the same energy be expended there will be necessary $\sqrt{8}$ times the E.M.F. used with the coarse carbon, but $\frac{1}{\sqrt{8}}$ of the current. This would mean that, with the same lamp expenditure for given illumination, one ton of coal would be lost on the conductors for the high resistance lamp, to 8 tons for the low resistance one, supposing r not increased—a strong argument in favour of high resistance carbon.

Our first conclusion would then be to diminish the diameter, and increase the length and resistance of the carbons, meeting this increase by an increased E.M.F.

But in a system of general distribution, safety from fire due to piercing the insulation, abnormal increase of current when short circuited, and immunity from harm, when by any accident the body forms a part of the circuit, demand a low electromotive force. Sir William Thomson has said, I believe, that this should never exceed two hundred volts. Even this will give some persons a disagreeable shock, and a lower electromotive force may be used with advantage.

Again, recent experiments seem to show that, no matter how perfectly the lamps are made, if the E.M.F. is too high, after the lamps have been in use a little while, a voltaic discharge will take place and soon destroy the carbons.

Another point of consideration is the increasing of the resistance of a carbon, while the length, diameter, and weight remain constant. As before, we see that the E.M.F. must increase as the square root of the ratio of increase of the resistance, and this resistance must be determined by the limit of electromotive force, the size of carbon that can be manufactured, and the degree of illumination required. We will call this carbon, the carbon of smallest section, highest resistance, and standard illuminating power, the standard lamp. Now, while we have this standard, it is evident that we want to be able to increase the power of illumination at sundry points, and this increase of illumination must be produced, for the most satisfactory result, not by a corresponding increase of intensity per unit, but by an increase of the illuminating surface, and the increase of energy expended should be in no greater ratio than the increase of light. These remarks are partially founded on the fact that an increased temperature shortens the life of a lamp, and that the most reliable results are to be attained by having carbons for all degrees of power of the same texture, and made by the same process as the standard, which standard shall in every way be as near perfect as possible, all such carbons to have the same weight, same length, same degree of carbonisation, same resistance, and consequently require the same electromotive force, and the same expenditure of energy. For the lamps of higher power we manifestly cannot use a carbon of greater length and correspondingly higher resistance, for this means a higher E.M.F., which is out of the question. Nor can we ecomonically increase the diameter of a circular section carbon, for the resistance diminishes inversely as the square of the increase of the illuminating surface of same intensity. There are three ways, where each lamp shall be independent.

One is by increasing the number of carbons in a lamp, they being arranged in parallel circuit; another by increasing the width of the carbon while the thickness remains the same; in other words use a flat carbon, so that the illuminating surface will increase in the same ratio as the weight of material. Now, with a double illuminating power, we use the same texture of carbon, the same temperature and intensity per unit of surface, double the illuminating surface, one-half the resistance, the same electromotive force, double the current, and double the energy. By a third method the carbon can be increased in length while its resistance per unit of length and area is diminished. This, I think, will be the future light.

Aside from the energy expended in the lamps and motors of a circuit, a certain amount goes into the generator to magnetise the field magnets, and this is represented by the same expression we have already used where the difference of potential at the terminals of the machine and the resistance of the field coils enter as factors. There is another expenditure in the armature coils and the conductors, dependent on their resistance and the current flowing, and still another at the brushes of the commutator, which would be greatest with large currents. The friction of bearings, the slipping of belting, if used, the force necessary to overcome the inertia of moving parts consume a further portion of power. Now, of these components, which are over and above that power which is expended in the lamps and motors, those which magnetise the field and overcome the friction of bearings and the inertia of moving parts remain about the same whether one lamp or a thousand are in operation. This is, considering the kind of machine, I think necessary in a system of general distribution, in which this extra work would be chargeable to a large number of lamps.

Consideration of the above and some other points which will be obvious on mention leads me to the following conclusions :—

1. The resistance of the armature of the generator should be as low as possible compatible with the power to furnish the necessary electromotive force.

2. The generator should be able to produce this E.M.F. with the field magnets at less than the maximum economic saturation, and at a velocity less than that at which the armature can be safely run, in order that there may be a margin for increased efficiency in case of an unexpected demand.

3. The lamps and motor should have a high resistance, the standard lamp not higher than 475 to 500 ohms. I will later on give the reason for this particular limit.

4. The resistance of the conductors should be as low as practicable, and should be graded in size for the current required.

5. The E.M.F. of the generator should never rise to over 170 volts.

6. The lamps should be simple of construction, durable and cheap, and all alike.

7. The generator and the engine should be of the most substantial construction.

8. The points of derivation should all have, and all be maintained at, the same difference of potential as nearly as possible.

9. The energy necessarily lost in armature and conductors of any fixed resistance for lamps of the same absolute economy varies inversely as the resistance of the lamps, or as the squares of the currents used.

10. Since in a single generator the total power used is not proportional to the number of lamps in circuit, a machine should be run nearly to its maximum capacity.

11. There should not be a single generator or a single circuit which may be destroyed, but such an arrangement that the external demands, both with regard to resistance and current required, may be met by suitable changes in the resistance and supply of the generative system.

12. The relation of internal and external resistance should be the same in a system as exists in a single generator when worked to nearly its full capacity.

13. With such proper relation of internal and external resistance the electromotive force will vary but slightly, and the power used will be very nearly proportional to the number of lamps or the current developed.

14. Insulation of conductors and of the armatures should be good, and provision made to prevent fire arising from an abnormal increase of current.

15. Means should exist of accurately measuring the current used.

16. A large system should be as economical as a single generator worked nearly to its full capacity, and should be capable of regulation with the came ease.

Much has been said about the subdivision of the electric light, the subdivision of the current, and such subdivision of electricity has been the great bugbear in the distribution of power

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and light through its medium. This term, while conveying an idea, is in reality essentially wrong. It implies the existence of a current, the expenditure of energy, before the required subdivision of such current is made. We do not wish to subdivide a current; a current which must be divided before it can be used is not a desirable current.

If we have a reservoir of water dammed up to a certain height, and tap it at the depth, say, of twenty feet, a stream of water will issue proportional to this height and the size of the orifice, and the amount of water flowing in a unit of time will be constant if the height of water above the outlet be kept the same. By damming up the water we have established a certain potential, but there is no flow of water, no current, and, consequently, no supply until the orifice is made. Such orifice, aided by the potential of the water, in itself establishes a flow, and creates the necessity for a supply. If we make another, a larger outlet, a larger amount of water will issue, and the amount in the first will not be changed, if the height of the water remain constant. By opening this second channel we created an additional current, and the necessity for a further supply, but such necessity, such flow, did not exist until the creation of the new demand. Our reservoir may be large, our source of supply may be great, but if a sufficient number of openings be made, both reservoir and supply will be fully used, and while expensive for a single channel will be economical for the whole.

So it is in the distribution of electricity. A current is a function, not alone of potential, but of potential and resistance. We desire to establish a certain potential, or difference of potential, and to maintain this so that, when a circuit is established, a channel opened, a current may be established in that circuit. We do not divide a current, do not divide a potential, but having established a difference of potential in two conductors, we open one or more paths, and a current flows over these paths dependent on their resistance, and independent of each other, and such additional current having been formed, the current over the main conductor is increased by just such increment, which increment did not exist until the new path was made. There has been no subdivision of a current, there has been a creation. Such new current having been made, of course, more power must be supplied to maintain the existing potential, and while the system may be expensive for a single lamp or motor, when the number of derivation circuits becomes sufficiently numerous, it will only be what is required for an economic and efficient supply.

THE GULCHER ELECTRIC LIGHT AND POWER COMPANY.

The first ordinary general meeting of this Company was held on Tuesday at the Cannon-street Hotel, Mr. John Blundell in the chair.

Mr. C. B. CHARLEWOOD (the secretary) having read the notice convening the meeting,

The CHAIRMAN said: This, you are aware, Gentlemen, is the meeting called the statutory meeting, which is held by Act of Parliament four months after the registration of the Company. It is not usual to go into any very great detail or formal business at these meetings, but I think it only right and just to the shareholders that they should know how far we have progressed with this Company. You are aware that the Company started only in May, and, therefore, of course, there has not been much time to do anything. But, however, the secretary will read to you a report of the business as far as it has gone, and I think, so far, I can assure you everything is as satisfactory as it can be. Of course, the time of the year is not good for bringing out a company, or one or two companies, such as we had in hand, and we have now decided that they shall stand over till November. I will now call on the secretary to read the report.

Mr. C. B. CHARLEWOOD then read the following report, viz.: The Company was incorporated on the 1st May last, and the first allotment of shares was made on the 10th of the same month. The total number of shares that have been applied for is 28,147, of which number 27,937 have been allotted to 307 shareholders, leaving a balance of 2,063 to be taken up before a quotation on the Stock Exchange can be obtained. On the 16th June an agreement was entered into with Mr. William Crookes, F.R.S., by which the Company undertook to purchase his incandescent lamp upon very favourable terms. The directors congratulate the shareholders upon having acquired this light, as an incandescent lamp is indispensible for household lighting, and they consider Mr. Crookes's lamp by far the most perfect invented, both as regards durability and economy. The directors have also the pleasure to announce that Mr. Crookes has accepted a seat on the board, and they feel assured that the Company cannot but deirve great benefit from the services and advice of such an experienced and well-known electrician as Mr. Crookes. The directors beg to announce that they have disposed of a concession for the sale of Gülcher dynamos and lamps in Scotland, and that they are negotiating for the sale of further concessions for districts or towns. The Gülcher light was exhibited at the *fêtes* of the Royal Horticultural and Botanical Socities, and was very much admired both for its brilliany, steadiness, and softness, and H.R.H. the Duchess of Teck, on the occasion of the *fête* at the Botanical Gardens, sent for Mr. Gülcher, and congratulated him upon the success of his light. Messrs. Ransome, Josselyn, and Woods, of Battersea Foundry, who are manufacturing dynamos and lamps for the Gülcher Company, have, of course, had great difficulties to contend with at first, as, with the exception of Mr. Gülcher and his foreman, the work was comparatively new to all; but the directors are happy now to be in a position to announce that those difficulties have been successfully overcome, and that dynamos are now being manufactured at Battersea which Mr. Gülcher pronounces to be perfect in every respect. Lamps of various candle-power are also being manufactured. A special factory has been constructed at Battersea for the manufacture of Crookes's incandescent lamps, where they are now being made, and in a short time it is expected that they will be turned out at the rate of over 1,000 per week. The directors are happy to say that they have numerous orders in hand for installations from various parts of the country, and that the plant for the execution of these orders will be delivered during the course of the next month. They are also negotiating with subscribers to hire the light from two large centres, the net income from one of which alone will be from £5,000 to £6,000 per annum, and the second centre referred to is likely to be on quite as large a scale. The directors have decided to send exhibits to the North-East Coast Exhibition to be held at Tynemouth, commencing on the 6th September; at the Crystal Palace Electrical Exhibition, commencing in October next; and also at the Royal Aquarium Electrical Exhibition, to be held during the coming winter. The directors have the pleasure of stating that arrangements have been come to between the Company and one of the most influential firms in New Zealand to represent them there as their agents; and they expect shortly to conclude a similar arrangement with another eminent firm for representation in India. Both these agencies are likely to result in the formation of large branch companies in these colonies. The directors think that they may congratulate the shareholders upon the prospects for the future of the Company being most promising, and they look forward to the shares of the Company rising considerably in value at no far distant date.

The CHAIRMAN: Having heard this report, Gentlemen, I have very few words to say in addition to it. I am not aware that it is usual to move the adoption of a report, but, still, the report is issued for the benefit and for the information of the shareholders. The directors are quite confident that the Company is in every way likely to prove a successful one, but of course it requires time. You no doubt have all read the report of Dr. Siemens's speech at Southampton the other day, in which he stated his perfect confidence that the electric light will be the light of the future. No doubt it will be the light of the future, but it will take some time before the lighting of houses and domestic lighting is carried out, in consequence of the very great difficulty in obtaining motive power for centres; but as regards the arc light for factories, and incandescent light for mines, there is not the slightest doubt that the electric light is the light for the future. We have made the best terms possible with Messrs. Ransome, who are very large manufacturers, and by making terms with them we have been able to save the very large expenditure of capital which has been the case in many other companies. Of course you are aware that the manufacture of dynamos and machines of every description which are new requires considerable time, but Messrs. Ransome have done their best, and have succeeded in turning out several very valuable machines, and no doubt during the next month or six weeks they will turn out a good many more. In similar companies they have taken some time. I do not know how long the Brush took, but certainly a year or two before they turned out any good machines, and therefore I think, so far as we are concerned, we have to congratulate ourselves on being more successful. As regards Mr. Crookes's incandescent lamp, there is no question it is the best and cheapest yet produced. We have Mr. Crookes's lamp, which we purchased on very good terms. Mr. Crookes has joined the board. Perhaps Mr. Crookes is one of the best professors of electricity in the country, and no doubt his adddition to the board is a very valuable one, because when any question arises as to a difficulty in regard to a particular light or machine, Mr. Crookes is here to give us his valuable advice, and I am sure it will be the study of the directors to watch the shareholders' interest and keep down the expenses and carry on the Company in the best possible way. As regards the concessions, there is no doubt we should have had one or two more very good concessions had it not been for the state of affairs in the East. There has been a scare through the state of affairs in the East, and therefore we thought it better not to carry out any till the autumn. As regards one concession, to show the *bona fides* of the gentleman, he has paid £1,000 deposit, which is a proof that he thinks well of it. There is another concession we thought would be well and good for us, but it has fallen through, and I am happy to say it has, because the terms were not the most favourable to the Company, and we have still that part of the country to deal with. I think, gentlemen, I have no further information to give you. I am very glad indeed to have had the pleasure of meeting you, and I hope next time we meet I shall be able to report most successful progress. This is only a formal meeting, and therefore the information we now give we give voluntarily for the sake of the shareholders.

Mr. BRIERS: There is one question I should like to ask, and that is whether you have given your consideration to secondary battery accumulators?

The CHAIRMAN: Yes, we have given our consideration to secondary batteries. Of course that is a very wide question, but I can assure the gentlemen of this, that we have under consideration at present the principal new secondary battery, which we are told has been extremely successful and is very cheap. If it is what we are told it is we shall purchase it, and carry it out. The managing director informs me that it is at Messrs. Ransome's works, and we are testing it now. But, of course, these things require very great consideration: enormous prices are asked for those different patents, several have been offered, but the special one offered to us, we are told, is the very best and the cheapest yet out, and if it is what we are told it is we shall certainly purchase it for the Company, which will make the system complete. We sha l then have the best arc lamp, the best incandescent lamp, and, we hope, the best accumulator. As this, gentlemen, is the first meeting, and as our Company bears the name of Mr. Gülcher, whom I wish to introduce to the meeting, I think it only right I should take the opportunity of naming him to you. He has done his very best to meet our requirements in every way. We have engaged his services for a certain length of time, and I can assure the shareholders he has given the board every satisfaction. He is extremely anxious to meet the shareholders in every way, and I think we are very much indebted to Mr. Gülcher for the interest he has thrown into the concern.

Mr. GULCHER: Gentlemen, I am convinced that my new system of

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electric lighting is a good one, and as I have hitherto done my best I assure you I will do it in the future. Excuse my bad English, I am an Austrian, and it is difficult for me to speak.

The CHAIRMAN: If any other gentleman would like any further information I am quite ready to answer to the best of my ability any question that may be asked. There is nothing we wish in any possible way to conceal, and if there is any gentleman in the room who would like to ask any question in connection with the Company, I shall be most happy to answer him.

Mr. CORNELL: As no one seems inclined so ask a question I have great pleasure in moving a vote of thanks to the chairman, and I may include the directors. No doubt they have done everything they possibly can, as we know from what we have heard, and I believe the shareholders will be perfectly satisfied.

Mr. BRIERS seconded the motion, which was carried unanimously.

The CHAIRMAN returned thanks on behalf of himself and colleagues, and the proceedings then terminated.

THE MEDITERRANEAN EXTENSION TELEGRAPH COMPANY.

The fifteenth ordinary general meeting of this Company was held on Thursday at the Cannon-street Hotel, Sir James Carmichael, Bart., in the chair.

Mr. EDWARD TOMBS (the Secretary) read the notice convening the meeting, and the report of the directors was taken as read.

The CHAIRMAN said: Well, Gentlemen, in moving the adoption of the report and accounts that have been submitted to you, I would simply draw your attention to the fact that the result of the working, as stated in our report, has been so far satisfactory that there has been a slight increase of traffic during the past half year, and that is notwithstanding the interruption of about two months of the Corfu-Otranto cable. Well, with regard to the interruption I may state that the repairs to the cable were conducted in a most satisfactory manner. We were, unfortunately, unable to obtain any steamer in the Mediterranean capable of effecting a repair to our cable, but we were able to charter a small steamer from Messrs. Henley's, and that took on board some cable and proceeded to repair the damage. Well, she was a little delayed by bad weather, but on arriving at the spot where the interruption occurred the repairs only occupied about twelve hours, and I am happy to inform you that we only used one and a half miles of new cable. There is another satisfactory circumstance connected with these repairs to which I wish to draw your attention, and that is the admirable state in which we found the cable. That cable was laid in 1859, and I must say that it reflects the greatest credit on the firm who laid it, Messrs. Glass, Elliott, and Co., that the cable is in quite as good a condition as when it was laid. I never saw a better bit of cable. That is very encouraging to us, because our other cable, which carries the bulk of the traffic between Malta and Sicily, has been laid down ten years later. If the one which was laid in 1859 is in so good a condition, how much better must be the one laid ten years later, and so far that is an encouraging fact. About this time last year we reported negotiations were going on for the transfer. These negotiations fell through, as we told you at our last meeting. They have now been renewed, but I am not in a position to-day to lay any definite offer before you. The negotiations are still proceeding, and what I should propose would be that if there is anything we think desirable for you to adopt, and the board can recommend to you, we should call a special meeting for your consideration of any subject to be proposed. That meeting may be called some time late in the autumn. I do not know that I have anything more to draw your attention to, except that I am sure, with us all, you will lament the death of Mr. Samuel Gurney, who has been a director of the Company from its formation. I do not think I have anything further to say, excepting to move the adoption of the report, and if any shareholder will second it, before putting it to the meeting I shall be happy to answer any questions.

Mr. ATWOOL: I will second it.

Mr. CRAFTER: Before you conclude any definite arrangement with any other company, you will call a meeting of shareholders?

The CHAIRMAN: Most distinctly. We should not entertain any proposal without first submitting it to you for your sanction.

The SOLICITOR: We could not do it without the consent of the shareholders.

Mr. CRAFTER: When does the Government subsidy expire?

The CHAIRMAN: In December, at the end of this year.

A SHAREHOLDER: What will become of the reserve fund of £12,000?

The CHAIRMAN: The reserve fund belongs to the Company.

A SHAREHOLDER: And the Company will go on just the same afterwards?

The CHAIRMAN: If you do not make any arrangement with any other company.

A SHAREHOLDER: We have no defective cables?

The CHAIRMAN: We have no defective cables.

Mr. VEARS understood that negotiations had taken place, but the chairman had nothing good to tell them.

The CHAIRMAN: I have nothing substantial.

Mr. VEARS said they only met once in six months, so that if there were anything satisfactory the shareholders ought to know it. Of course he might be doing the chairman an injustice, because he had not arrived early enough to hear his speech. He would, however, like to know if there was anything on which they might base their hopes.

The CHAIRMAN: I think you must be aware in business matters, and when negotiations are going on, it is very unwise to discuss them. It would be very imprudent, and damaging I may say, to say we hope to do this or we hope to do that. I think you had better trust your board. I have already given you the assurance that no step will be taken without first consulting you.

Mr. VEARS: We may take it for granted the negotiations are going on.

The CHAIRMAN: Yes.

A SHAREHOLDER: Supposing the negotiations fall through and come to nothing, what will be the prospect of the ordinary shareholders?

The CHAIRMAN: Supposing that the Government decline to assist us in any form or way whatever hereafter, then you would have to depend entirely on the earnings of the line. At the same time you must remember this that the line between Malta and Sicily is of some importance in the present state of complication in the East.

A SHAREHOLDER: Would the earnings be sufficient to pay the preference shares?

The CHAIRMAN: No doubt, but not the ordinary shares.

A SHAREHOLDER: What is the average amount the Government give towards the guarantee?

The CHAIRMAN: The subvention of the Government was £7,200 a year, and the average we have received from them since the commencement of the line is rather less than half. For several years we never called upon them at all for any portion of that subvention, but it was after they sanctioned the landing of another line at Malta that part of our traffic was diverted.

The CHAIRMAN, in reply to a shareholder, said that the reserve fund was invested in Consols.

A SHAREHOLDER: Have the preference shareholders any claim on the £12,000.

The CHAIRMAN: I think it is equally divisible amongst all shareholders. I am not a lawyer, but I believe that to be the case.

A SHAREHOLDER: I think the gratifying statement you made with regard to the life of a cable should not be lost sight of. It somewhat upsets the theory with regard to the life of a cable, because we have one that has been down twenty years and it is quite good.

The CHAIRMAN: Quite so. I have had as much experience of cables as most people, and perhaps more, and I never saw a cable in a better condition.

A SHAREHOLDER: Do I understand the Government guarantee was £7,200, and you receive the whole of that annually?

The CHAIRMAN: No, we have never had occasion.

The SHAREHOLDER: I see there is £3,600 credited for the present half year.

The CHAIRMAN: We have taken the whole this half year on account of the injury to this cable. This year we have claimed the whole. That has caused us so much expense that we have had to call on the Government to pay up in full. Usually we only asked for half—some years for nothing.

A SHAREHOLDER: How long does the guarantee last?

The CHAIRMAN: I have told you it expires at the end of this year.

The motion for the adoption of the report was carried unanimously.

Sir James Carmichael and the Hon. Ashley Ponsonby, the retiring directors, and Messrs. Allwright and Hayward, the retiring auditors, were re-elected.

The CHAIRMAN proposed the usual dividend at the rate of 8 per cent. per annum, less income-tax, on the preference stock, and on the ordinary stock at the rate of 3 per cent. per annum, free of income-tax.

The motion was seconded by the Hon. ASHLEY PONSONBY, and carried.

A SHAREHOLDER proposed a vote of thanks to the chairman and board of directors for their management of the Company's affairs. Although they had not been so prosperous as they should like, he was sure the directors had done their best, and were as much interested in the Company as the shareholders.

The motion was seconded and carried unanimously.

The CHAIRMAN: I beg to thank you most sincerely for your kind vote of thanks and confidence, and you may depend upon it that directly we have anything to communicate we shall call you together. We shall do nothing without your consent.

The proceedings then terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES AUG. 30.		BUSINESS DONE WEEK ENDING AUG. 30. Highest.	Lowest
Anglo-American	49½,	50½	50	49¾
Do. Preferred	80,	81	80½	80¼
Do. Deferred	19¾,	20¼	—	—
Brazil Submarine	11¾,	12	11¾	11⅝
Cuba	9¾,	10¼	10⅛	10
Do. Preference	16,	17	17	16¾
Direct Spanish	6,	6½	—	—
Do. Preference	15,	16	—	—
Direct United States Cable	11¼,	12	11¾	11⅝
Eastern Telegraph	10½,	10¾	10¾	10½
Do. 6 per Cent. Preference	12¾,	13	13	13
Do. 5 per Cent. Debentures, 1899	100,	105	—	—
Eastern Extension	11¼,	11⅝	11⅜	11¼
German Union	9¾,	10¼	—	—
Globe Telegraph and Trust Company.	6⅜,	6⅝	6½	6⅜
Do. Preference	12¾,	13	13	12⅞
Great Northern	12¼,	12¾	—	—
Indo-European	29,	30	—	—
Mediterranean Extension	2,	2½	—	—
Do. Preference	8½,	9	—	—
Reuter's	12¾,	13¼	—	—
Submarine	255,	265	—	—
West India and Panama	1¾,	2	1 15-16	1¾
Do. 1st Preference	8½,	9	9	8⅝
Western Brazilian	6¾,	7¼	6⅞	6 13-16
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	103,	106	—	—

TELEPHONES.

COMPANIES.	CLOSING PRICES AUG. 30.		Highest.	Lowest
Consol. Telephone and Maintenance	1¼,	1⅝	1 5-16	1¼
Oriental	⅜,	⅝	⅝	9-16
United Telephone	9¾,	10¼	10	9¼

ELECTRIC LIGHT.

COMPANIES.	CLOSING PRICES AUG. 30.		Highest.	Lowest
Maxim-Weston	⅜,	⅝	9-16	⅜
Anglo-American Brush	10,	11	13½	10½
Eastern Electric	1¾,	2	2	1¾

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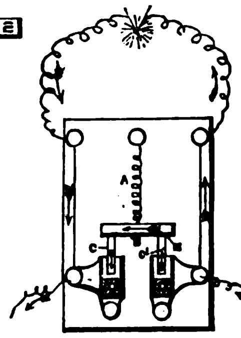
RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

4792. IMPROVEMENTS IN SWITCHES OR APPARATUS EMPLOYED IN CONNECTION WITH ELECTRIC LAMPS, FOR CLOSING THE CIRCUIT ON THE EXTINCTION OF ONE OF THE LAMPS, AND FOR LIGHTING AND EXTINGUISHING THE LAMPS, &c., *W. E. Hubble, Lincoln's Inn-fields.—2nd November*, 1881.—(*A communication from J. M. A. Gérard Lescuyer, Paris.*) 6*d*.

The diagram shows the method of carrying out this invention. Two metal rods, C C^1, are connected by a cross bar, B, the cups D D^1 are partly filled with mercury, and are arranged so that when the lamp is working correctly, rod C is always immersed in the mercury, but rod C^1 is elevated above it. When the lamp goes out or ceases working, the current passes through the

4792

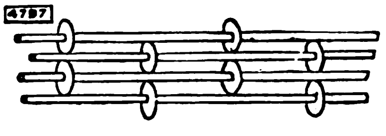


mercury in cup D by rod C, and through a platinum helix, A, by which the rods are suspended. The latter becomes heated, and losing its elasticity, allows the rods to descend by gravity, until C^1 makes contact with mercury in D^1, and cuts the lamps out of circuit. Various modifications in the means for carrying this invention out are described, including a method for using the apparatus as a switch to re-light the lamp.

4797. IMPROVEMENTS IN AND RELATING TO TELEGRAPHIC OR TELEPHONIC CABLES AND CONDUCTORS, *C. L. Gore, New York and London.—2nd November*, 1881. 6*d*.

This relates to the insulation of wires. The inventor threads a series of rings of glass, earthenware, or other material on the wires, in the manner shown in the figure. For under-

4797



ground work a cable composed of wires thus insulated is enclosed in an inner tube of porcelain, which again is enclosed in an outer tube of iron, both of which are formed of two parts fitted to one another and secured by bolts. The inner tube is also filled with insulating material.

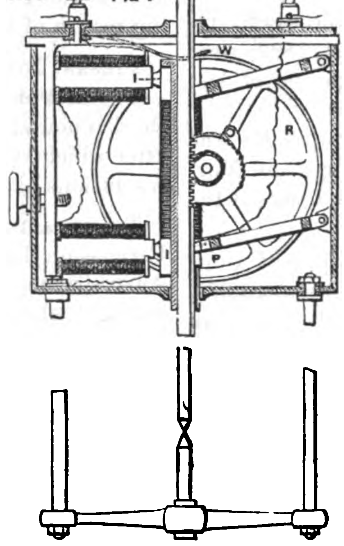
4472. A NEW OR IMPROVED ELECTRIC METER OR APPARATUS FOR MEASURING AND REGISTERING THE QUANTITY OF ELECTRICITY PASSED THROUGH A CONDUCTOR, *C. V. Boys, Wing, near Oakham.—13th October*, 1881. 6*d*.

This relates to a method for measuring and registering the quantity of electricity passed through a conductor, by means of clockwork with an escapement governed by a pendulum or balance, the oscillations of which are determined by the force of an electro-magnet having its coil in the electrical circuit, so that according as a less or greater quantity of electricity passes through the circuit, the amount of movement permitted to the clockwork is less or greater. A counter connected to the clockwork shows by suitable indices the quantity of electricity that has passed in a given time. The specification is accompanied by drawings of the meter.

4820. IMPROVEMENTS IN ELECTRIC LAMPS OR REGULATORS, *W. L. Wise, Westminster.—3rd November*, 1881.—(*A communication from E. Bürgin, Basel, Switzerland.*) 6*d*.

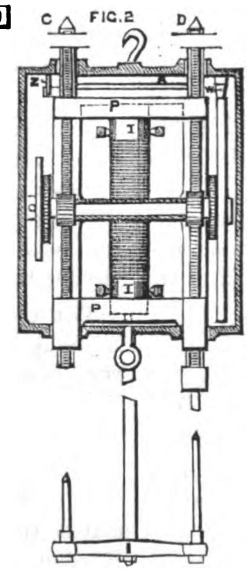
This invention relates to a mode of regulating arc lamps with two sets of carbons, as shown in Figs. 1 and 2. When a current traverses the lamp armature I is attracted, raising it and the two carbon holders, with their support, P. By this movement brake wheel R makes contact with spring W, which prevents it rotating. Carbon C is not raised so far as carbon D, owing to the

4820 FIG I



action of a spring lever, A, on D, which bears heavily against it, but only lightly against C. When the arc gets longer the current through the magnet gets weaker, armature I descends, the pressure of W on R lessens, the wheel rotates, until the arc regains its normal length, and wheel R is again held by W. When the first set of carbons are consumed the upper carbon holder passes below the plane of the spring lever A. As the arc increases in length the attractive power

4820 FIG.2

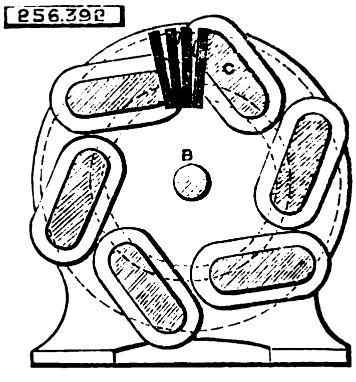


of the magnet diminishes, until the armature falls sufficiently low for A to pass below a fixed stop, Z, and occupy a position in the other side of it, where it no longer bears against carbon holder D, which accordingly descends, completes the circuit, and the arc is again established between the fresh pair of carbons. The patent also describes a modification of the above lamp in which one pair of carbons only are used. Fig. 1 shows a front elevation, and Fig. 2 a side elevation of the lamp with two carbons.

256,392. DYNAMO-ELECTRIC MACHINE, *Henry B. Sheridan, Cleveland, Ohio.—Filed August 22nd*, 1881.

Brief.—The construction is clearly indicated in the drawing and claim. The purpose is to avoid wide breaks in the inductive action of the machine and produce a nearly uniform current. *Claim.*—

256.392

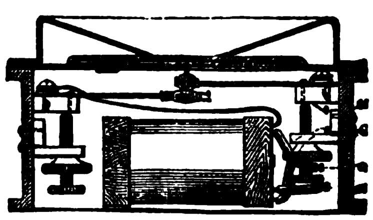


A dynamo-electric machine constructed substantially as herein shown and described, with its magnets, C, made oblong in cross section and arranged around the armature shaft B, with the side of each magnet in the series nearly overlapping the edge of the adjacent magnet, substantially as herein specified.

257,687. TELEPHONE TRANSMITTER, *James P. Freeman, Treat T. Prosser and H. B. Prosser, Chicago, Ill., assignors to the Home Telephone Company, of Illinois.—Filed 22nd October*, 1880.

Claim.—(1) A tension regulator composed of a compressed compound of steel filings, coke, lampblack, and balsam of fir, substantially as before specified. (2) The combination, substantially as before specified, of the spring arm, the button

257.687

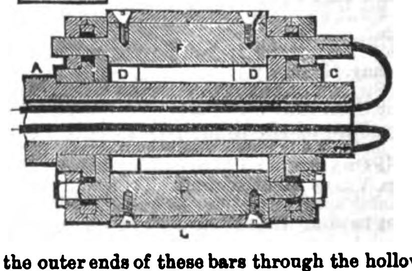


secured in a ring thereof, and the platinum fail strips inserted between the button and its encircling ring. (3) The combination, substantially as before specified, of the spring arm carrying the button or tension regulator, the rigidly-secured but somewhat elastic non-conducting bracket supporting said arm, and the adjusting screw acting on said bracket.

258,022. COMMUTATOR FOR DYNAMO-ELECTRIC MACHINES, *Charles A. Cooley, New Britain, Conn.—Filed March* 14, 1882.

Brief.—The commutator bars are carried by, but insulated from, flanges mounted on the shaft of the machine. The armature wires are connected

258.022



to the outer ends of these bars through the hollow shaft, and removable wearing plates are fastened to the bars by screws. *Claim.*—(1) In commutators the flanged hubs C, insulating washers, D, rods, F, and copper segments, G, combined on the shaft A, substantially as described. (2) The recessed insulating washers D, in combination with the flanged hubs C of a commutator, substantially as described. (3) In commutators, the rods F, having enlarged middle portions, in combination with the flanged hubs C and washers, D, substantially as described.

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SLIP

Telegraph Extension in Victoria.—The telegraph line has been extended to Yarram in Victoria and an office opened.

Brazilian Submarine Telegraph Company. — The traffic receipts of this company for the week ended Sept. 1 amounted to £3,508.

Direct Spanish Telegraph Company.—The traffic receipts of this company for the month of August, 1882, were £1,790, against £1,507 in the corresponding period of last year.

Underground Wires in France.—The pipes for the underground cables which are to connect Paris and Marseilles have now been laid as far as Baix, on the banks of the Rhone.

South African Telegraphs.—The receipts of Cape Colony from its telegraphs during June last were £5,377, against £5,255 for the same month of 1881, being an increase of £122.

The Telephone in Italy.—The Italian Government is considering the question of establishing telephone exchanges in the towns of Italy. A Bill has been laid before Parliament on this subject.

Mr. Pender.—Mr. John Pender, M.P., is now on a visit to the United States. The fact of his having paid a visit to Mr. Jay Gould has, of course, given rise to all kinds of absurd rumours.

Electric Light at Portsmouth.—The Town Council have accepted the offer from the Edison Electric Light Company to light a district of the town for six months, at the cost of gas, light for light.

Eastern Extension Telegraph Company.—The traffic receipts of this company for the month of August amounted to £32,025, and to £30,349 for the corresponding period of 1881, being an increase of £1,676.

West India and Panama Telegraph Company.—The estimated traffic receipts of this company for the half month ended the 31st of August were £1,992, as compared with £1,763 in the corresponding period of 1881.

Cable Interrupted.—It is notified that the Shanghai-Nagasaki cable is interrupted. Messages for China can, therefore, only be forwarded by the Indo-European or the Eastern Extension Companies' lines.

Telegraphic Extension in Canada.—According to recent news from Canada, the Canadian Pacific Railway has now be laid for a distance of 350 miles from Winnipeg, a telegraph line being pushed on concurrently with the railway.

Electric Light at Beccles.—We learn that the Provincial (Brush) Electric Light Company have made arrangements with the Corporation of Beccles, in Suffolk, for lighting some of the principal streets of that town with their arc lamps.

Port Said.—A correspondent of a daily contemporary telegraphs, under date Port Said, September 4, as follows:—"Last night the Eastern Telegraph Company sent an expedition under Mr. Tuck to a fix land line between here and Kantara."

Halifax and the Electric Lighting Act.—The Town Council of Halifax have appointed a committee to consider this Act, and to report as to what steps should be taken in reference to applications for licenses to supply electricity in that town.

Western and Brazilian Telegraph Company.—The traffic receipts of this company for the week ending September 1st were £2,464, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

Cuba Submarine Telegraph Company.—The number of messages passing over the lines of this company during the month of August was 2,581, estimated to produce £2,550, against 2,354 messages, producing £2,401 in the corresponding month of last year.

Pilsen, Joel, and General Electric Light Company.—The first ordinary meeting of this company will be held at the Cannon-street Hotel, E.C., on the 11th inst., at 2 p.m., after which an extraordinary meeting will be held to pass resolutions altering the Articles of Association.

Telegraphic Extension in Western Australia.—Permission has been given to the Government of Western Australia to raise a loan of £260,000 for public works, amongst which we notice the construction of a telegraph line to Roeburn. This will absorb £50,000 of the above sum.

Jablochkoff Electric Light Company.—An extraordinary general meeting of this company will be held at the Cannon-street Hotel, E.C., on the 15th inst., at 2 p.m., to pass a special resolution altering the Articles of Association, and the statutory meeting will be held immediately afterwards.

Electric Light at Sudbury.—We are informed that arrangements have been completed by the Provincial (Brush) Electric Light Company with the Corporation of Sudbury (Suffolk) for lighting the Market Hill and neighbouring streets with arc lamps. The lights were started on Saturday last.

Great Northern Telegraph Company.—The traffic receipts of this company for August, 1882, amounted to £23,360. For the period from 1st January to the 31st August, 1882, they were £160,560, against £158,240 for the corresponding months of 1881, and £154,075 for the same period of 1880.

Electric Lighting in Canada.—According to recent news from Canada, electric lighting in Ottawa was at a standstill for want of sufficient motive power. It is stated that agreements have been made for lighting the grounds of the forthcoming Industrial Exhibition at Toronto by the electric light.

The Crystal Palace Exhibition.—The *Journal of Gas Lighting* announces that £3,018 17s. have been subscribed by various gas companies towards the expenses of the Special Committee of the Gas Institute, who are undertaking the organisation of the gas exhibits at the forthcoming Exhibition at the Crystal Palace.

The Meteorological Stations at the Poles.—It is stated that the New Norwegian meteorological station at Bosekop, on the Alten Fiord, established in accordance with the arrangements of the International Polar Commission, commenced operations on the 1st of August. Great magnetic perturbations are said to have been observed during the night.

The Telephone in Bombay.—The Oriental Telephone Company have concluded satisfactory arrangements in Bombay for the formation of a local company there, to be called the "Bombay Telephone Company (Limited)," embracing the Bombay Presidency, including Scinde and Hyderabad (Deccan), the capital of which has already been fully subscribed.

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The Edison Station at Holborn.—In addition to the two large dynamos with steam engines combined now working at the Edison Company's central station on Holborn-viaduct, the company are making preparations for laying down another dynamo and engine combined of even greater power than the others, which are of 1,000 lamp capacity or thereabouts.

Telephonic Communication with Vessels.—An experiment was recently tried at Havre to ascertain the possibility of communicating with ships from the shore by means of the telephone. Cables were laid between ships lying at sea and offices in the town. It was found that conversation could be maintained, even when the wind was strong and the sea high.

Extension of Electric Lighting.—The Jablochkoff Electric Light Company have taken large premises on the Albert Embankment, to be used as a manufactory for their carbon candles and as a lighting centre. They are also about erecting a building on the Victoria Embankment, for the purpose of more effectually carrying out the contract with the Metropolitan Board of Works.

Jamaica.—The Government of this colony sent no delegate to the recent Telegraph Conference at Barbadoes, and the local press does not seem inclined to support the resolutions arrived at by that conference, which, if adopted, would pledge the colony to the annual payment of £7,500, whereas at present the subsidy paid to the existing company is only £2,000 per annum.—*Colonies and India.*

Another Danger from Overhead Wires.—It is stated that the frightful railway accident which happened at Hugstetten, near Mulhouse, in Germany, on the 3rd of this month, and by which many persons (variously reported as from 50 to 100) lost their lives, was caused by telegraph poles which had fallen across the rails, and which caused the engine to leave the track and run into a deep morass by the side of it.

The Telephone and Collieries.—At Ahlen, in Westphalia, the mining company of Goerne and Co. have established telephonic communication between their offices and the two pits which they work. The length of the line is sixty kilometres. The line is soon to be extended to Hamm, where the central office of the company is situated. The work was carried out by the firm of Arnim Teller, of Berlin.

An Electric Railway in Switzerland.—A telegram, dated Geneva, Sunday last, states that a syndicate of London capitalists, represented by Mr. Pearson, of the firm of Messrs. John Taylor and Company, have contracted with the canton of Geneva for the construction of an electric railway on the Edison system between Geneva and Fernex, and Fernex and St. Julien, in the Savoy, a distance of about 20 kilometres.

Electric Light for Inverness Station.—The Highland Railway are considering proposals from several electric lighting companies to light the Inverness Station, the Station Hotel, the offices, and the locomotive works by electricity. Representatives from these companies have visited Inverness, and have examined the entire works in order that they may be prepared to lay offers before the railway directors.

The Use of the Telephone.—According to recent telegrams from Paris we learn that M. Grévy, the President of the French Republic, and Madame Grévy have left Paris for Mont-sous-Vaudrey, in the Jura. M. and Madame Wilson remain at the Elysée, whence they will be able to communicate with M. and Madame Grévy by means of a telephone line, which has been constructed between the Elysée in Paris and Mont-sous-Vaudrey.

The French Atlantic Cable.—The cable steamer "Scotia," Captain Cato, belonging to the Telegraph Construction and Maintenance Company, left Plymouth on Saturday, to renew her efforts to repair the French Atlantic cable. As stated in our last week's issue, the cable, after being repaired a thousand miles from Plymouth, again parted within twenty miles of the original breakage. The "Scotia" has taken coal and provisions for two months.

Legal.—According to the New York papers, a suit has been brought by the United States Electric Lighting Company of New York and others against the Edison Electric Light Company of New York. The former company maintain the priority of the claim of one of their *employés*, W. K. Freeman, of Milwaukee, to the invention of an incandescent electric lamp. Freeman claims that Edison borrowed his ideas from a lamp Freeman had sent Edison for inspection.

Egypt.—A recent telegram from *The Times* correspondent at Ismailia says:—"The Intelligence Department derives much advantage from the services of Mr. Clarke, telegraphic superintendent of this district, who by sending false telegrams on the day of our landing at Ismailia to Arabi's officers prevented the massing his troops to oppose us. Mr. Clarke's knowledge of the district and of the language and habits of the people has been of the greatest service during the advance."

Brighton.—The introduction of the electric light into Brighton having rendered the poverty of the present gas lighting somewhat conspicuous, the gas committee of the town council have recommended an increase in the consumption of gas in the principal streets from 4ft. per hour per lamp to 6ft., and in less important streets to 5ft. per hour. This will result in an additional consumption of 2,672,278 cubic feet of gas per year. We may also mention that gas has come down from 3s. 6d. to 3s. 3d. per 1,000 in Brighton this year.

Electric Light in the British Museum.—The reading room of the British Museum has been provided with four new Siemens arc lamps, which are adjusted so as to give equal light over the whole room. These will be in operation every evening from the present time until the 1st of April next, so that the room can be kept open until 8 p.m. Swan lamps are used within the hall and in the out offices. The work has again been entrusted to Messrs. Siemens Brothers, they having successfully lighted the room and offices by the same arrangement of lamps during last winter.

Electric Light at Eastbourne.—Not long since we noticed that the Eastbourne Local Board had contracted with a local company to light the parade by means of the Brush system. The first lighting by this means took place on Friday week. We believe that several of the principal streets are also to be lighted by Brush lamps. Sixteen lamps are in use on the parade, the last of them being some two miles from the engine and dynamo. The length of cable used is four and a-half miles, all of which is underground. The lighting has been carried out by the Eastbourne Electric Light Company, under the superintendence of Mr. H. M. Sayers, electrician.

Electric Lighting for Libraries.—Amongst the papers read at the annual conference of the Library Association of Great Britain held during the week at Cambridge, was one by the librarian of the Liverpool public library, on "Electric Lighting in Public Libraries," in which he stated that he had found the light suitable. At Liverpool the arc system

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was utilised, but he was not prepared to advise the adoption of any particular system. A saving had been effected in the expenses. In the discussion which ensued a large number of librarians strongly supported the incandescent system of lighting for library purposes and for small rooms.

The Telephone in Bradford.—The Telephone Company at Bradford recently coupled up their subscribers with the technical school on the occasion of a recitation of Shakespeare's *As You Like It*, by Mr. Ellaby. Thus subscribers in Halifax, Leeds, Dewsbury, and Huddersfield were able to hear the recital, given at Bradford, in their own homes. We believe that the company intend to continue this practice, and to give their subscribers the benefit of any performance taking place in Bradford by the same means. One of the chapels in Halifax is in telephonic communication with the head office of the company at Bradford, so that each Sunday the service is heard in Bradford.

The Telephone and Rifle Shooting.—According to *La Lumière Electrique*, the telephone was used for the first time at the shooting meeting of the territorial army at the grand camp near Lyons, as a means of communication between the markers at the targets and the shooting points. The telephone line, an aërial one, was composed of two conductors insulated by being covered with caoutchouc, and wound on a bobbin carried in a special haversack. Each bobbin holds 700 metres of wire, which the soldier carries in his haversack, and unwinds on the march. Gower-Bell telephones are used. By this means much time is saved in ascertaining the facts as to doubtful hits, &c.

Electric Lighting on Board Ship.—The Cunard Company evidently believe in the incandescent lamp as a means of lighting the saloons and interiors of their vessels, several of them being now fitted up with Swan incandescent lamps. The latest addition to the fleet, the "Pavonia," made her trial trip off the Clyde on Saturday last. She is 5,587 tons gross register, 445ft. long, 46·3ft. wide, and 36·5ft. deep, and is built of iron throughout. She is, therefore, not quite so large as the "Servia," though she is said to be equally commodious. She is lighted throughout with Swan incandescent lamps, each state room, of which there are 45, having one of these lamps, which can be turned on or off at the pleasure of the occupant.

Nickel in Oregon.—At a recent scientific meeting in San Francisco announcement was made of the discovery in Southern Oregon of a large deposit of nickel ore, resembling that discovered in New Caledonia in 1864, the development of which by the French has so greatly extended the economical use of this metal. The New Caledonia minerals are known as garnierite and noumeite, both hydrated silicates of nickel and magnesia, occurring with chrome iron, steatite, and other minerals found only in serpentine. There are, likewise, says the *Scientific American*, two of the Oregon minerals, one dark, the other pale apple green, like those of New Caledonia, and closely corresponding with them in hardness and specific gravity.

The Electric Light for Nightwork.—A smart piece of work was carried out on the Taff Vale Railway recently by the aid of the electric light. The company has been laying a third line of rails, and it became necessary to remove a massive stone bridge on the main line and substitute iron girders, and yet not interfere either with the passenger or coal traffic. The work was begun on Saturday, and successfully finished by Sunday night, a large body of men being employed. The Maxim-Weston Electric Company supplied the electric lamps and machinery required to generate the light necessary to enable the work to be done by night. The whole operation was carried out under the superintendence of Mr. H. O. Fisher, of the Taff Vale Railway Company.

Gas and Electric Lighting in Hull.—At a recent meeting of the Hull Town Council a letter was received from the Secretary of the British Gas Company, stating that the prices of the public lamps in the district supplied by the company would be reduced to £2 15s. per lamp per annum, and the smaller lights in the same proportion, the reduction to date from the 30th June last. It was stated at the meeting that this reduction amounted to 10s. per lamp. It is no secret that the Town Council and the Gas Company have been a little at variance over the high price charged for the gas, and that the council have concluded a contract with Messrs. Siemens Bros. to light certain portions of the town for one year by means of their arc lamps. The great reduction indicated above, taken in conjunction with these two facts, is interesting as showing what a little pressure will do in the way of cheapening gas.

New Form of Commutator.—Mr. Charles A. Cooley, of New Britain, Connecticut, U.S.A., has patented a commutator constructed so that the wearing segments may be quickly renewed without disturbance of the armature wires or the removal of the commutator from its shaft. The armature shaft is made tubular to receive the wires from the armatures, and on this shaft are flanged metal hubs, having at each side vulcanite washers for insulating the hubs. Rods extending through the flanged hubs and the washers are enlarged between the two hubs, and are insulated by sleeves of vulcanite. To these rods segments of copper are secured by screws to form the wearing surfaces of the commutator. The copper segments are of suitable thickness to sustain the wear of the commutator brushes for a reasonable length of time, and can be easily removed by taking out the screws and new segments put in place.

Telephone in Rangoon.—We extract from a recent issue of the *Rangoon Times* the following account of the opening of the Oriental Company's Telephonic Exchange in that city:—"The Telephone Exchange just established in the City by the Oriental Telephone Company (Limited) was opened, with some ceremony, by the Chief Commissioner of British Burma, on Wednesday evening. After the working of the apparatus had been exhaustively explained by Mr. Mathews, Mr. Bernard, the Chief Commissioner, proceeded to declare the Exchange open. He congratulated the company on their success, and said that the establishment of a telephone exchange in Rangoon showed what rapid advances this city was making in all that contributed to mercantile prosperity. He had great pleasure in declaring the Exchange open, and he hoped that before the end of the year every office in Rangoon, both public and private, would be in connection therewith."

Hailstorms and Forests.—In explanation of the phenomenon that the presence of forests is a safeguard against hailstorms, which has recently been demonstrated in Switzerland, *The Times* Geneva correspondent states that Herr Riniker suggests (in a paper read by him and Herr Beaumont, of Argau, before the Association of Swiss Geographical Societies recently held at Geneva) "that, as hail clouds are saturated with positive electricity, and trees conduct from the earth negative electricity, the meeting of the two currents develops sufficient heat to prevent the complete congelation of the clouds, and even to thaw the hailstones contained in them—for the clouds of this description pass very near the earth—and so convert the frozen particles into rain.

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If further observation should confirm the accuracy of Herr Riniker's conclusions in this regard, the importance of forests in countries where hailstorms are frequent will be greatly increased."

VILLAGE TELEGRAPHS.—"A Villager" writes to *The Times* of 5th September, under the above head, as follows:—"Before our popular Postmaster-General parts with some of his increasing surplus by conceding sixpenny telegrams, may not the claim of dwellers in villages be heard—the claim of those persons who have to add to their shilling's worth one to two or more shillings before they get their message delivered? Surely, sir, the telephone may be made to accomplish this, and also become an enormous feeder to the telegraphic system. No training, as formerly, to the needle or A B C instrument would be needful. Any existing keeper of a post office with ordinary quickness of hearing would do the work. Why should not wires be put up from telegraphic centres to a belt of village post offices, either with or without a guarantee for business by inhabitants? The telephone has removed the operating difficulty, and that of delivery would only be on a par with hundreds of existing offices where the service is only occasional."

ELECTRIC LIGHT FOR SOUTHPORT.—The Southport Town Council are losing no time. They have been sending letters, through their town clerk, to the surrounding local authorities, stating that it is their intention to apply to the Board of Trade for a provisional order to enable them to supply electricity for lighting purposes. As, however, they are advised that, "in order to give the public the full advantages of the electric light, the installation must be upon a scale of considerable magnitude, and that the limits of the borough and its population are not sufficient to enable the best economical results to be obtained," therefore they "think it desirable to apply for powers to supply electricity not only within their own local government area, but also within that of [in the case under notice] the Birkdale Local Board." The letter then goes on to express a hope that the board will not oppose the corporation in this matter. This, however, the board decided it was its duty to do, and not only passed a resolution to oppose the corporation in the matter, but also requested their gas committee to report on the desirability of obtaining a license to supply electricity on their own account in that district.

ELECTRIC LIGHTING IN NEW YORK.—A telegram from the *Daily News* New York correspondent, dated Tuesday last, says:—"The first experiment of lighting sections of the city with Edison's incandescent electric lamps was made successfully last evening. Mr. Edison has laid eighteen miles of wire in pipes, and has placed 16,000 lamps in stores and offices. The work has been completed in about a third of this section, and 5,000 lamps along six miles of wire were burning last night, the circuit including the *Times* and *Herald* buildings and some large offices. In all of these the light was soft, perfectly steady, and seemed more evenly distributed than from gas burners, while it gave out only a fifteenth of the heat of gas. The expense will be a trifle less. The lamp circuits have a porcelain shade over an air-tight pear-shaped ground-glass globe four inches in diameter, in which is a carbon horse-shoe. All the subscribers express satisfaction with the experiment. Lights half-a-mile from the supply station burned as brightly as those in the station. When the work in the section is completed 22,000 lamps will be supplied from one section." The *Standard* correspondent states that there are in the district 1,500 consumers of gas, of whom 1,100 have subscribed for the electric light.

THE FIELD TELEGRAPH TRAIN IN EGYPT.—The telegraph train with our army in Egypt is placed under the control of the commanding officer of the Royal Engineers, and is to be divided into two portions—that in front of the advanced depôt, and that between the advanced depôt and the base of operations. Arrangements have been made for detachments of soldiers to patrol all the telegraph lines to prevent the wires being cut or tapped by the enemy, and for military guards to protect the telegraph stations. Stores have been sent out for twelve stations. In addition to the necessary telegraph waggons and reels, there have been sent out twenty-four "sounder" instruments for the dozen stations, and fifteen Morse instruments for field work, together with 360 rolls of Morse paper, 48 Leclanché's 10-cell batteries, 500 insulators, 200 iron telescopic telegraph poles, a large number of wood poles, 12 lightning protectors, 12 wheels for cypher signalling, 1,200 yards of copper wire covered with gutta percha, 36 miles of insulated copper wire, and 36 miles of insulated galvanised iron wire. In addition to the above, the Royal Engineers have taken the necessary apparatus for effecting communication by means of visual signals, between different military stations. Among these are 36 hand-draw telescopes for field observations, 72 gas-bags, and 36 pressure-bags for the limelight for night signalling, 36 limelight lamps, 72 large powerful bull's-eye signalling lamps, 36 heliographs, 36 fog-horns, and 72 army signalling flags and poles.

THE LATEST FROM NEW YORK.—A New York contemporary says:—"Ten square feet of the pavement in Nassau-street, near Ann, became suddenly bewitched early yesterday afternoon (August 24). The first indications of the change were noticed when a farmer, driving a sleepy sorrel nag, drove over it. In the twinkling of an eye the old mare began a double-shuffle on the cobble-stones. 'I've driv that 'ere mare nigh on to ten year, and I swar I never knowed her to act like that afore,' he remarked to a bystander upon the sidewalk. Next came a big truck loaded with paper. No sooner had the horses stepped upon the magic spot than they dropped upon their knees and delivered several kicks towards the driver's nose. By this time a crowd of spectators had gathered round the mysterious place. Three policeman got their heads together and held a consultation. 'What kin we do?' said the spokesman. 'Put a barrel over it,' replied one. 'Spake to the Cap'n and have it arrested,' said the other. In the meantime a pedler of tinware, with a ten dollar skeleton of a horse, drove through the crowd. At the moment he entered the charmed circle his quadruped gave a snort, and, with ears erect and tail pointing toward the North Star, dashed down the street at a 2:40 gait. Roars of laughter followed the terror-stricken pedler as he grasped the reins with one hand and with the other endeavoured to hold down his dancing stock in trade. Nassau-street never contained such a jolly crowd or beheld such a free circus. Bankers, lawyers, clerks, and bootblacks laughed till the tears ran down their cheeks. At length somebody suggested that there might be a break in the Edison Electric Light wires which, contained in iron pipes, run through this street. Word was at once sent to the branch office in Pearl-street, and, the current being shut off, all the strange qualities of the mysterious spot immediately disappeared. The disappointed audience soon melted away, and the business of the street was again resumed. Workmen discovered last evening that the cap at the end of the pipe leading into a building had slipped down and established a connection with the earth. In this way the electricity was allowed to escape!"

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RECENT PROGRESS IN TELEPHONY.*

BY WILLIAM HENRY PREECE, F.R.S.

The telephone was first introduced to the British public at the meetings of the British Association. In 1876, at Glasgow, Sir William Thomson startled his hearers by announcing that he had heard, in Philadelphia, Shakespeare quoted through an electric wire, by the aid of the invention of Mr. Graham Bell, which he then pronounced to be "the greatest by far of all the marvels of the electric telegraph." In 1877, at Plymouth, I had the pleasure of showing in actual operation the finally developed instrument now known as the Bell Telephone, which I had just brought over from America; and conversation was actually maintained between Plymouth and Exeter. Five years have elapsed since then, and it is fitting that the British Association should hear of the progress of this astonishing apparatus.

In 1877 it was a scientific toy; it has now grown to be a practical instrument. £1,550,000 capital is already embarked in its extension in England, and it is earning a revenue of £109,000. Hitherto it has been practically a monopoly in the hands of a private company, who hold the controlling patents, and of the Post Office, who possess the controlling power, but this monopoly has been broken, and we are about to witness severe competition. It is often said that competition in any business will have the effect of reducing the rates charged to the public, but the experience of the past in railways and telegraphs scarcely teaches this lesson. Undue competition tends to lower the rates for a time, but it eventually leads to amalgamation—to the absorption of the weak by the strong—to swollen and watered capital, and finally, in many instances, to higher rates to a too-confiding public. Competition, however, induces better service, and ultimately, in this respect, the public gain.

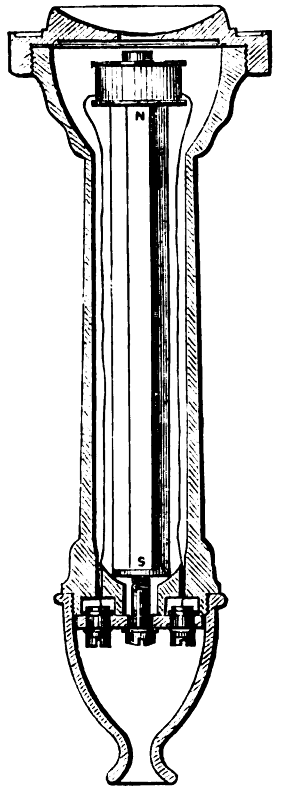

Fig. 1.

The free traffic in patents, however, leads to jobbery and speculation of the worst type. We have recently seen a mania for electric speculations that almost rivals the South Sea Bubble period. The public have wildly rushed into ill-matured schemes that have swollen the purses of gambling promoters, have turned the heads of inventors, have retarded the true progress of the beneficial application of this new science to the wants of man, and have thrown away millions upon imperfect schemes. Much has been said against the monopoly of the Post Office in telegraphic business, but at any rate it has the merit that it has checked the rapacity of company promoters and patent-mongers in that branch of the practical application of electricity, while no one can assert that it has checked the progress of telegraphy. During the first week that the telegraphs in this country were transferred to the State, the total number of messages transmitted was 26,000, while in the week ending July 28 it amounted to 724,000. There is no inventor who can assert that his scheme has not received proper consideration, nor show a real improvement that has not been adopted and remunerated; while the improvements of the Post Office itself are freely adopted by other countries, and America itself—the home of the inventor—has found the advanced system of England worthy of acceptance.

Receivers.—The original telephone receiver of Bell (Fig. 1) has scarcely been improved upon; it remains in form and construction very nearly the same as that which I exhibited in 1877. The perfection of its working depends upon the truth and perfection of its manufacture. It is now more solid and substantial than it was at first, more powerful magnets are used; but still it is the same simple, marvellous, and beautiful instrument that I brought over from America. Mr. Gower has increased its loudness by varying the form of its various parts, and using very powerful horse-shoe magnets of peculiar form; but experience shows that loudness is always obtained at the expense of clearness of articulation; and, although for many purposes the Gower-Bell instrument (Fig. 2), which is adopted by the Post Office, and is now in use to connect together all the sections of the British Association scattered through the town of Southampton, is more practical, nothing for delicate articulation surpasses the original Bell.

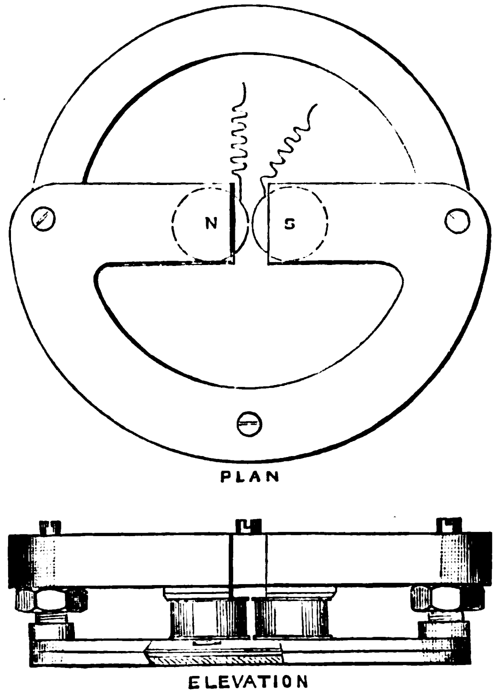

Fig. 2.

The Paris Exhibition of last year, so fruitful in electrical novelties, did not bring forth any marked improvement in telephonic apparatus. It was noticeable chiefly for its practical applications of the telephone, and particularly to the transmission of singing and music to a distance. M. Ader's modification of Bell's receiver (Fig. 3) is that almost universally used in Paris. It is a very handy, pretty, and convenient form. He utilises a principle which he calls "surexcitation." A thick ring of soft iron is inserted between the ear-piece and the diaphragm, and this is said to increase the attractive power of the little horse-shoe magnet upon the vibrating iron

* A Paper read at the Southampton meeting of the British Association.

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diaphragm. A simple experimental apparatus of M. Ader's shows that there is some foundation for this fact. When a thin steel spring is adjusted close to the poles of a magnet without being attracted by them, the near approach of a mass of iron to the spring will cause it to be attracted by the magnet.

D'Arsonval has also modified the Bell receiver (Fig. 4). He has placed the coil in a powerful magnetic field of annular form, and has thereby concentrated the lines of force upon the induced coil. He brings the whole coil within the influence of the field. The effects are said to be magnified, and the increased loudness not accompanied by the usual loss of articulation. Speech is reproduced without any change of *timbre*.

Telephone receivers of the Bell type are all based upon the magnetic effects of currents of electricity flowing around magnets or bars of soft iron.

The rapid and rhythmic magnetisation and demagnetisation of a bar of iron, or the increment and decrement of the magnetism of a magnet, will produce molecular disturbances in its own mass and in the matter about it, that lead to the oscillatory motions of the whole which produce sonorous vibrations that can be made manifest by various devices, and particularly by that patented by Graham Bell.

Other principles of electricity have also been utilised for telephonic receivers.

For instance, Mr. Edison used the electro-chemical effect. The decomposition of a chemical solution in paper or on chalk by the passage of currents through it, produces a modification of the friction of two moving surfaces, which can reproduce sonorous vibrations, and the result is a very loud-sounding apparatus. I myself had the pleasure, in 1880, of submitting to the Royal Society a receiver based on the electro-thermal effects of the current. The passage of a current through wires always heats them, and, therefore, produces expansion. If the wire be made fine enough, the heat is generated and dissipated so rapidly, the expansions and contractions are so quick, that sonorous vibrations are the result. Although I was able to speak through it very clearly, I have not as yet developed this instrument into a practical form. Professor Dolbear has recently utilised the electrostatic effects of currents. His receiver is even more simple than that of Bell. Two flat circular discs of metal are rigidly fixed very close to each other in an insulated case of ebonite. When one disc is electrified positively by a charge of electricity, the other is electrified negatively by induction. These two opposite states produce attractions varying in force with the strength of the signals sent, and the result is that, when telephonic currents are transmitted, we obtain sonorous vibrations, and, consequently, the reproduction of speech.

ADER'S RECEIVER

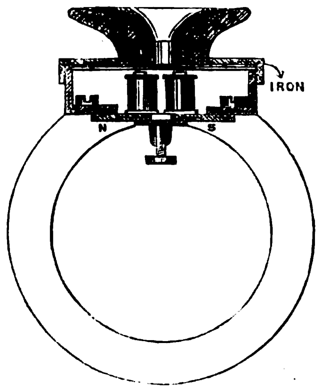

FIG. 3.

Many other forms of telephone receivers have been devised and exhibited, in fact I have recently seen quite a crop of them; but as they involve no new principle, and introduce no particular improvement, having been brought out chiefly to try to avoid existing patents, I pass them over, and proceed to the next branch of my subject.

Our present Patent Law is, unfortunately, in so disorganised and chaotic a condition, that evasion is often possible, and hence the questionable morality of doing a thing in another way, in order to avoid the incidence of a royalty, is practically encouraged.

The possession of a patent is now no guarantee of property; it is granted without any discrimination, and cannot be upheld without tedious litigation and wasteful expenditure before a non-technical and scientifically incompetent tribunal. We, therefore, cannot hope for any virtue in English inventors or security for real improvements until our law is thoroughly revised. The question is before the House of Commons, and, when wordy agitators have fully exhausted the patience of our legislators, we may hope for some attention to so real and pressing a want.

Transmitters.—The great novelty and peculiarity of Bell's telephone was that the receiver and transmitter were similar and reversible. Sonorous vibrations of air impinging on an iron disc caused it to vibrate in front of a magnet around one pole of which a portion of an electric circuit was wound. These vibrations of a magnetic substance in a magnetic field produced currents of electricity in the coil of wire on the magnet, varying in strength and direction with the sonorous vibrations, which, proceeding along a wire to a distant station, there varied the magnetic strength of a similar magnet so as to vary its attractive force on a similar disc, by which it reproduced the motions of the first disc, and thus, reproducing the sonorous vibrations of the air, repeated speech. The currents, however, were very feeble; much energy was lost *en route*, and the effect scarcely attained a practical standard. Mr. Edison showed how to strengthen these currents. Taking advantage of a peculiar property of carbon which was supposed to vary in electrical resistance with the amount of pressure brought to bear upon it, he caused the vibrating disc which was spoken against to press upon a button of carbon, and so to vary the strength of a current of electricity passing through it. This varying current, passing through the primary wire of an induction coil, set up in the secondary coil more powerful currents than the Bell instrument produced, and caused louder and more marked effects at the receiving station. Professor Hughes went a step further. He found a combination of materials that were directly affected by sonorous vibrations, which he called a "microphone," and he proved that the effect of the carbon transmitter of Edison was not due to any influence of varying pressure on the mass of the carbon, but was a phenomenon of loose contact. He found a new fact in nature, and he startled the scientific world by introducing an instrument which did for minute sounds what the microscpe had already done for minute objects. By the light thrown on the theory of the instrument by Hughes, Edison's carbon transmitter has been so improved by Blake, Hunnings, Moseley, Anders, and others, that little apparently remains to be done. The telephone as a speaking instrument is now well nigh perfect. It is quite possible to swear to a friend's voice at 100 miles distance. The difficulty of making the telephone a practical instrument under all circumstances is not due to any defects in the instrument itself, but to disturbing influences external to it, and consequent on its surroundings. The very perfection and sensitiveness of the apparatus itself are its chief enemies.

D'ARSONVAL'S RECEIVER

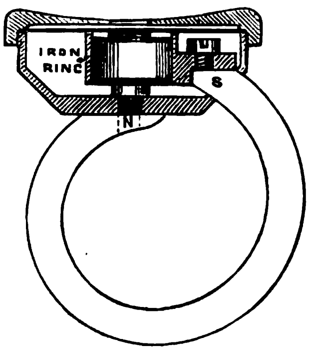

FIG. 4.

The true action of the microphone, or carbon-transmitter

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is very little understood. It introduces into a closed electric circuit, through which a current is flowing, a resistance which, varying exactly with the sonoreus vibrations impinging upon it, causes the current to undulate in a way exactly analogous to the varying sound waves. This effect is generally assumed to be due to a greater or less intimacy of electrical contact between two semi-conducting surfaces abutting upon each other; but there is now little doubt that it is due to effects of heat generated by the passage of electricity between two points in imperfect contact, whose relative distance is variable. Carbon is the best material for the purpose—first, because it is inoxidisable and infusible; secondly, because it is a poor conductor; and, thirdly, because it has the remarkable property of having its resistance lowered when it is heated—the reverse of metals. This observation is due to Mr. Shelford Bidwell.

The resistance of microphones is very variable. Some give 10^{ω}, while others give 25^{ω}, and some even 125^{ω}. The best transmitters that I have worked with (Moseley's) give an average of 20^{ω}.

Attempts have been made to apply mathematical analysis to the determination of the best form and arrangement of microphones, but at present the microphone defies mathematics.

Theory would lead to the conclusion that a carbon-transmitter should have the lowest possible resistance, but practice does not confirm that idea.

Theory again asserts that the resistance of the secondary coil of the induction coil should be equal to that of the line it works, but practice proves the very reverse. On a line giving nearly $1,800^{\omega}$ resistance, the best effects were produced with a secondary wire of only 30^{ω} resistance. The fact is that the conditions due to heat in the microphone, and to self-induction in the induction coil, are very complicated, and are not yet sufficiently understood to bring the phenomena they affect within the region of mathematical analysis.

Accessories.—I do not intend to speak here of the bells, calls, switches, &c., used in carrying out telephonic operations. There has been nothing that is particularly novel introduced, or that was not previously used in telegraphy. In fact, the whole operations carried on in connection with the so-called "exchange" working are simply telegraphic, and are still in somewhat tentative condition.

Long-distance Speaking.—I have said that the difficulty in speaking is chiefly due to the environment of the wires employed. Were we to erect a wire from Land's End to John o' Groats, upon lofty separate poles and away from all other wires, there would be no difficulty whatever in speaking between those two places. Conversation has been held in America over 410 miles; in Persia it has been effected between Tabreez and Tiflis, 390 miles apart; in India, over a distance of nearly 500 miles; in Australia, of 300 miles; but in all these cases it was done either at night or under exceptional circumstances, and in all cases the wires were overground. Had they been underground or submarine, the case would have been very different. Conversations have been held between Dover and Calais, between Dartmouth and Guernsey, and between Holyhead and Dublin, but I know of no case where any persons have spoken through more than 100 miles of submerged cable. The reason of this diminution of speaking distance is due to the electrostatic capacity of the telegraph line, which absorbs the minute quantity of electricity that makes up the currents employed for telephonic purposes.

In every submarine cable, before a signal can be made at the receiving end, the whole cable must be charged up with electricity, and if there be not sufficient electricity sent in to effect this purpose, practically no signal appears at the distant end. With telephone currents on long cables the whole of the electricity is, as it were, swallowed up—that is, none appears at the distant end, or, if it does appear it is rolled up in one continuous wave, bereft of those rapid variations that reproduce sonorous vibrations. The newspapers said that the sound of the bombardment of Alexandria was heard at Malta; but, in the first place, the experiment was not tried, and even if it had been tried it could not have succeeded. The use of underground wires very seriously impedes telephonic extensions, and with our present apparatus and present knowledge we cannot readily speak over greater distances than 20 miles.

Disturbances.—But there are other disturbing influences at work of more serious import.

When two or more telephone wires run side by side, what is said on one can be overheard on all the others; and when a telephone wire extends alongside telegraph wires, every current on the telegraph circuit is repeated in the telephone, leading to a hissing, frying, bubbling sound that is not only very irritating, but which on busy lines entirely drowns speech. When music is transmitted on one wire, it can be heard equally well on all wires running parallel and contiguous. This is due to induction and to leakage.

(A). *Induction.*—Induction is a term employed to designate the peculiar influence which electrified and magnetised bodies exert upon conducting and magnetic masses in their neighbourhood. If two wires run side by side for some distance, every current of electricity sent upon one wire will produce two currents in the contiguous wire, the one at the commencement and the other at the end of the primary current of electricity. The greater the intensity, and the more sudden and abrupt the commencement and the ending of the inducing current, the greater effect it has on the induced wire. Those instruments, consequently, which reverse their currents the most rapidly and suddenly, produce the greatest disturbance. The powerful alternative and intermittent currents used for certain electric light systems are death to telephones; they cause an incessant roar that renders speech an impossibility. There are some apparatus in telegraphy that require very powerful currents to work them, which are equally detrimental. Many attempts have been made to cure this evil.

1. The sensitiveness of the receiver has been reduced to lessen the influence of the disturbing currents, and the strength of the telephonic transmitting currents has been increased so as to overpower the induced currents.

2. The influence of one wire on the other has been screened off by inserting metal coverings in connection with the earth between them.

3. The suddenness of the rise and fall of the inducing currents has been modified by the insertion of condensers or electro-magnets.

4. Counterbalancing or neutralising effects have been set up by counter-induction apparatus.

But all these plans, and many others, have been proved either only partially successful or wholly abortive. The only effective mode of curing the evil at present practically used is to employ a complete metallic circuit so contrived that the two wires are in very close proximity to each other, or that they twist round each other so as to maintain a mean average equality of distance between themselves and the disturbing wires. When we have the two wires of a circuit kept at the same mean distance from the disturbing causes, however near they may be, the influence on each must be identically the same, and as the one is used for going and the other for returning, the similar influences must be opposite in direction, and they must therefore neutralise each other. This plan, which was originally devised for underground wires by Mr. Brookes, of Philadelphia, was found to be absolutely true in practice, and the Post Office, having laid down many hundreds of miles on this system with perfect success, invariably constructs its circuits both underground or overground in this way. It is, of course, more expensive than a single wire, but the great gain—the absolute freedom from overhearing, the privacy, and the absence of crackling—is well worth the extra cost. Wires in submarine cables are invariably laid up with a twist, so that no special contrivance is needed on such wires, and in underground wires not laid up together as cables they are, as a rule, so close to each other that twisting is unnecessary; but for overground purposes twisting is essential, and special arrangements have to be carried out. Professor Hughes showed how this was to be done, and Messrs. Moseley carried it out practically in the neighbourhood of Manchester. The plan adopted by the Post

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Office for *two* and for *four* wires is shown by the diagram (Fig. 5). It is simply and easily carried out, and entails no practical difficulty whatever.

In the neighbourhood of Manchester there are over 400 miles of overground double wire twisted on this plan, working efficiently and thoroughly. I have spoken to a friend 76 miles off, through wires that were erected on poles carrying busily-occupied telegraphic currents, without disturbance or difficulty.

(B.) *Leakage.*—The double-wire system is only absolutely effective so long as the insulation is good. The moment insulation fails connection with the earth is made, and then we have disturbing causes due to currents flowing through the ground, which are increased in proportion to the deterioration of the insulation. Hence, good insulation is essential to telephone working.

The discovery of the telephone has made us acquainted with another phenomenon. It has enabled us to establish beyond doubt the fact that currents of electricity actually traverse the earth's crust. The theory that the earth acts as a great reservoir for electricity may be placed in the physicist's waste-paper basket, with phlogiston, the materiality of light, and other hypotheses. Telephones have been fixed upon a wire passing from the ground floor to the top floor of a large building, the gas pipes being used as a return, and the Morse signals sent from a telegraph office 250 yards away have been distinctly read; in fact, if the gas and water systems be used, it is impossible to exclude telegraphic signals from the telephone circuit. There are several cases on record of telephone circuits miles away from any telegraph wires, but in a line with the earth terminals, picking up telegraphic signals. When an electric light system uses the earth, it is stoppage to all telephonic communication in its neighbourhood. The whole telephonic communication of Manchester was one day broken down from this cause, and in the City of London the effect was at one time so strong as not only to destroy telephonic communication, but to ring the bells. A telephone circuit using the earth for return acts as a shunt to the earth, picking up the currents that are passing, in proportion to the relative resistances of the earth and the wire. The earth offers resistance, and consequently obeys the law of Ohm; hence it is not only essential for a telephonic system that the earth should not be used on any electric light system, but it is also desirable that the earth should be eschewed for telephonic purposes. Thus, the double-wire system adopted by the Post Office and by the Société Générale des Telphones of Paris not only cures the ill effects of induction, but it materially diminishes the disturbing influences of earth conduction. The four-wire system of the Post Office effectually checks leakage from one wire to the other—cross contact, as we call it in England—for each wire of the same current is always on a different supporting arm.

A telephone circuit when in connection with the earth gives distinct evidence of every visible flash of lightning, however far off the thunderstorm may be. No difference in time has been observed between seeing the flash and hearing the crash.

It is said that, if a telephone be connected between the gas and water systems of a house, distinct evidence of every flash can be heard. There have been several cases of persons being knocked down while experimenting during a thunderstorm, but no personal injury has been sustained, although the apparatus itself is frequently damaged. In England, at present, we have not found the damage done sufficient to justify the employment of lightning protectors. The use of double wires diminishes the danger to a minimum. On the continent and in America, however, where one wire only is used, telephones are invariably protected by lightning arresters.

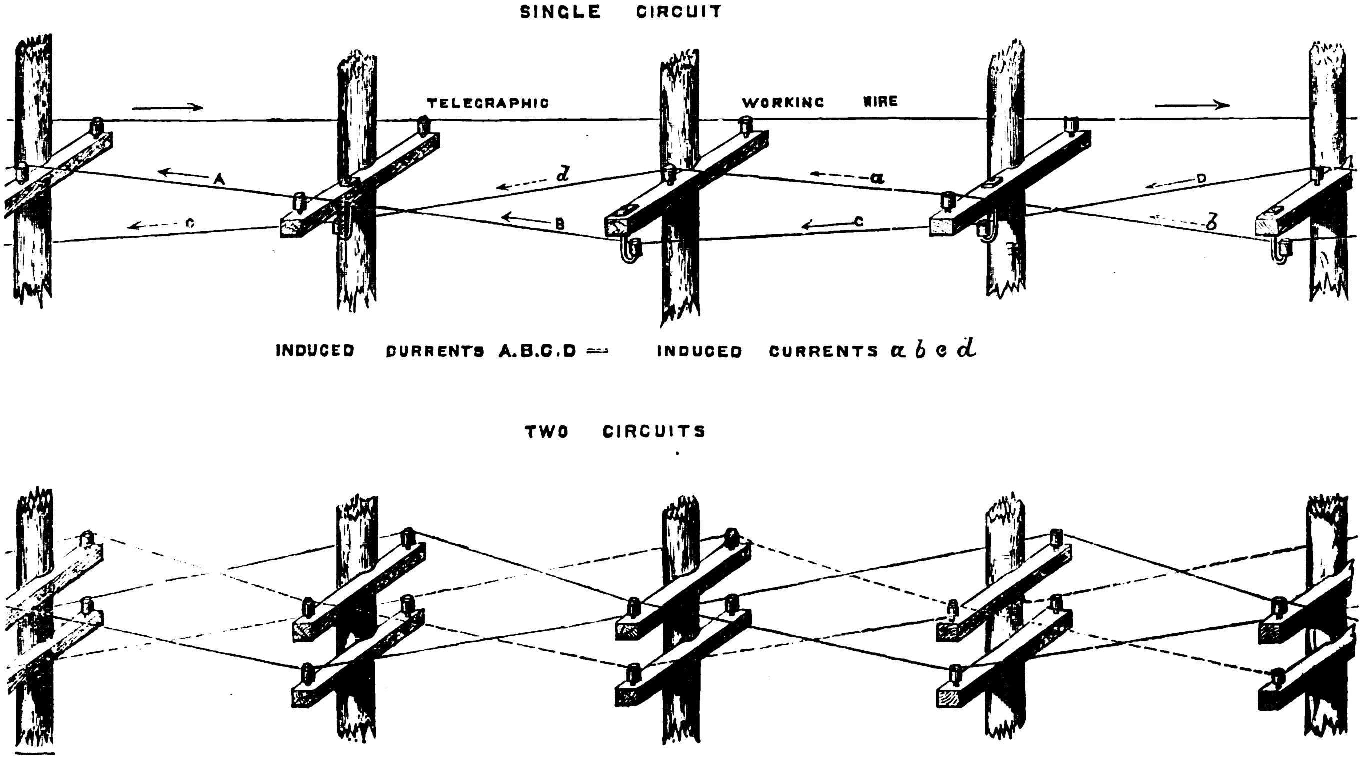

Fig. 6.

There are certain natural currents flowing through the crust of the earth. They are called "earth" currents, and at times acquire such considerable energy, that with a telephone pressed to each ear, I have been told, although I have not experienced it, that the noise made is as though "your brains were boiling." This is due to the intermittent currents produced by the polarisation of the earth plates.

M. Van Rysselberghe has recently spoken between Paris and Brussels upon a wire nearly 200 miles long, which was used at the same time for ordinary telegraphy, but the experiment was made early in the morning (4 a.m.), and was effected by retarding the telegraphic currents, so as to modify the suddenness of their rise and fall, by means of condensers and electro-magnets. I am unable to understand the advantage of any gain in speaking on a wire which is detrimental to telegraphic communication. Speed is of more importance than speech, and we can telegraph much faster than we can

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speak. In England speed is everything, and we eliminate every influence that retards speed—condensers and electro-magnets in telegraph circuits are out of the question. M. Van Rysselberghe has endeavoured to extend the idea to cure the effects of induction by destroying the main cause of the disturbance—that is, by reducing the sudden rise and fall of the prime telegraphic currents; but to do this means to retard telegraphy, and we cannot afford in England to cripple the one system in order to benefit the other.

I have recently tried an extremely interesting experiment between this place (Southampton) and the Isle of Wight, namely, *to communicate across seas and channels without the aid of wires at all.* (Fig. 6.) Large metal plates were im-

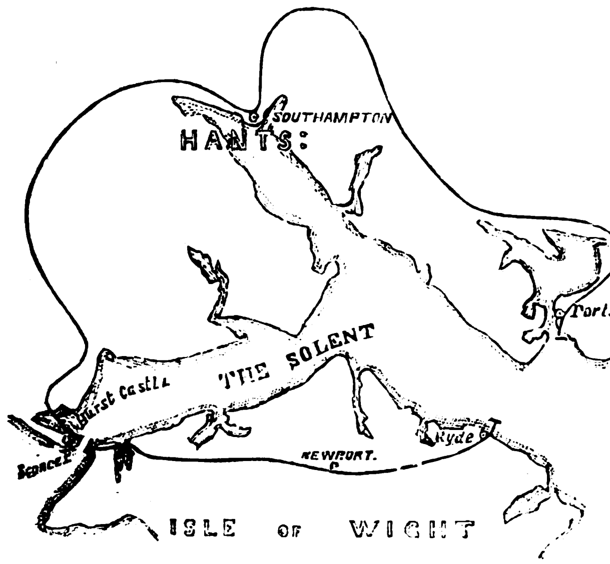

Fig. 6.

mersed in the sea at opposite ends of the Solent, namely, at Portsmouth and Ryde, six miles apart, and at Hurst Castle and Sconce Point, one mile apart. The Portsmouth and Hurst Castle plates were connected by a wire passing through Southampton, and the Ryde and Sconce Point plates by a wire passing through Newport; the circuit was completed by the sea, and signals were passed easily so as to read by the Morse system, but speech was not practical.

The telephone is very rapidly gaining ground, and, as improvements are effected in its accessories, in its installation, and in its mode of working, its use will still further extend. In Germany it is used very extensively for telegraphic business, there being 1,280 stations worked entirely by telephones, but in England it is not possible in the numerous open and public shops employed as post offices to secure that privacy which the telephone requires, nor have we yet got over our early prejudices, resulting from the errors made through the inability of the instrument in its earlier form to repeat the sibilant sounds. The instruments of the present day (thanks to the improved transmitters), however, transmit "s's" perfectly.

The Edison Light at the City Temple.—A correspondent of a contemporary says:—"Edison's incandescent lamps played some fantastic tricks on Sunday week at the City Temple, six pendants under the gallery threatening to leave that part of the building in darkness by bobbing nearly out, while one of the lamps collapsed with a sharp hissing noise. Some excitement ensued, and several ladies left their seats. After a quarter of an hour of comparative quietude one of the pendants in the upper side gallery, with three incandescent lamps, also collapsed with a loud cracking noise, and was followed later on by the failure of several other lamps which went off with an unpleasant report. The large congregation was somewhat alarmed, and many were about to make a speedy exit, when they were assured that there was no danger, and the service was proceeded with."

CORRESPONDENCE.

WHAT IS ELECTRICITY?

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In reply to Mr. Johnstone's letter I would remark that there ought not to be any obscurity as to my meaning—if the ordinary interpretation be accorded to my words—in my letter on Electricity, taken in connection with my previous letter on Gravitation.

In my letters entitled "What is Electricity?" I have endeavoured to throw some light upon the mode in which the sun's force correlates with the terrestrial forces, by showing that each form of terrestrial force is due to the mode in which matter, under different conditions, interferes with the *dual* force pertaining to the earth under the action of the sun.

I have shown that this dual force is the resultant, first, of the sun's force applied to the surface of the earth; second, of the proper motions of the earth's mass. The former is action, the latter reaction.

If I am right in my apprehension of the postulants, we perceive the mode in which the motion of the celestial bodies originates action, and reaction, or stress, also that every manifestation of power, natural or artificial, is bound to be associated with the third law of motion.

Under the circumstances named by Mr. Johnstone the flame of the candle is only the medium which renders those forces apparent; it is obvious that neither force arises within the flame, and equally so that the bent position must be assumed by the flame, because action precedes reaction. This principle of action and reaction is well illustrated by the opposition of two dissimilar magnetic poles.

Your correspondent, Mr. Jamieson, by his own showing, has criticised my remarks on the subject at issue, viz., What is Electricity? from only one of my letters. Criticism, to be fair, should embrace the text as well as the context. If Mr. Jamieson deems it worth his while to read all my letters on this subject, he will perceive that I have therein traced the first disposition of mass motion to the directive influence which matter exerts upon force by reason, as it would appear, of the manner in which the molecules have been primarily combined; and it is evident that the same principle governs the inclination of bodies to combine. It has been the custom to designate the matter in interplanetary space ether, but by whatever name it is called, or however attenuated it may be, it is matter, and, as such, is subject to force impressed upon it by the motions of the celestial bodies in accordance with the laws of motion.

It appears to me much more conducive to the apprehension of a somewhat abstruse subject to refer the motion of matter to the physical properties of matter as influenced by the laws of motion than to the "spirit of ether" or "sympathising ether," which terms are anything but expressive of the properties of matter.—Yours, &c.,

Reading, August 31, 1882. Richd. C. Shettle.

[This discussion must now close. Dr. Shettle will no doubt be able to finish the description of his theory in one or two more letters at the most.—Ed. *E.*]

MEYER'S SYSTEM FOR UNDERGROUND WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: It is, to say the least of it, remarkable that so few of the inventors who busy themselves with electric matters have turned their attention to so important a question as the laying of subterranean mains; and it is a relief to turn from the patents without number which deal with electric lamps and dynamo machines to a practical scheme, such as Mr. Meyer's appears to be.

The main questions in treating this subject will naturally be those of economy and durability; and from the perusal of Mr. Meyer's pamphlet I cannot but think that where large

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numbers of wires have to be dealt with these points have been very successfully met by him.

But it has occurred to me that Mr. Meyer's proposal for placing all electric and telephonic conductors in cities under *one* control raises a very important question indeed, and one which is of very great moment to shareholders in electric lighting companies.

The opposition made by the gas companies to the Electric Light Bill in Parliament was in the main ineffectual, but whether owing to the influence of "gas," or to the bad treatment the public have had to suffer from the gas monopoly in past days, the very unfair "Purchase Clause" is included in the Bill. As it now stands, an electric light company giving a public supply of electricity is compelled, after a certain lapse of time, to surrender its plant at a fair valuation. We may assume that municipal corporations will not err on the side of overvaluing such plant, and of all the machinery and requisites none is likely to have depreciation so freely undervalued as the street mains.

The less capital a company has, therefore, invested in street mains the better it will be for it when the purchase clause is put into operation.

Mr. Meyer's suggestion that a separate company should undertake the laying of street mains, and rent them out as required, is, therefore, well worth consideration, because as such mains would not be the property of the Electric Light Company they could not be acquired by the Corporation under the purchase clause. At the same time, as a corporation would not purchase an electric light company's plant, except with a view to continuing the supply of light to the public, the company owning the street mains would be as much assured of interest on its capital outlay as before.

In the light of experience of overhead wires in the United States, it seems to me impossible that we can long do without underground wires even for telephones and telegraphs, and as the laying of separate mains for all these interests would be a very great nuisance, it seems to me that Mr. Meyer's proposal is not only eminently practical, but the only possible course to pursue in the long run, more especially as his system provides for the insulation and protection of the smallest and largest conductors indiscriminately. I enclose my card.—Yours, &c., ENGINEER.

THE ELECTRIC LIGHT AT THE BIRMINGHAM MUSICAL FESTIVAL.

Of the large cities of England, Birmingham has hitherto had, probably, the smallest experience of electric lighting. Now and again a large hall has been illuminated with arc lights, and some years ago the Town Hall was vividly lighted up for the four nights of the Midland Institute *Conversazione* by a number of Jablochkoff candles, then the only system in use. There are one or two establishments in which the electric light is in use for trade purposes, but no attempt has been made to use it in the streets, and it is not likely that the light will be adopted here for this purpose, because the town owns the gas works, and derives from them a large sum in aid of the rates, besides which the public lighting is already efficiently worked. In fact, no street illumination by electric light has yet been produced which will compare favourably with the illumination of the great space around the Town Hall of Birmingham, where the principal public buildings are collected around the junction of many streets, and where such important centres of interest as the Town Hall, the Council House, the Post Office, Midland Institute, School of Art, and Masons' Science College call for and repay some expenditure upon illumination.

However, the occasion of the Triennial Musical Festival has furnished an opportunity for the exercise of the well-known public spirit and liberality of Birmingham manufacturers. Messrs. R. W. Winfield and Co., of the old-established Cambridge-street Works (one of the largest chandelier and gas fitting works in the kingdom), are entering the new field of electric lighting in conjunction with Messrs. R. E. Crompton and Co., whose position in that field is known to every one. These gentlemen offered to light up the Birmingham Musical Festival at their own expense, and that offer has been most thoroughly carried out. The arrangements were made by and the work carried out under the superintendence of Mr. Henry Lea, a consulting engineer of Birmingham, energetically supported by the officers and men of the firms of Messrs. Winfield and Crompton, and the result has been certainly the most thorough and satisfactory illustration of the power of the electric light which has yet been exhibited anywhere. The lighting, as to the interior, was wholly by Swan's incandescent lamps, of which 500 were employed. Their remarkable equality shows that great care has been exerted in the manufacture, with the result of considerable improvement upon those shown at the Crystal Palace. They now testify to the experienced eye, and by the work they do, that a so called 16-candle light is really giving the light of 16 candles, a matter which called for the exercise of much faith in some of the exhibitions hitherto made.

The power is derived from the ordinary steam engine which for 30 years has been in action at the Cambridge-street works rolling metal and working the machinery. It is a low pressure, condensing engine, having a fly-wheel 24ft. in diameter, running 48 revolutions per minute. The necessary speed for driving dynamo machines is obtained by a system of belts. A belt from the fly-wheel itself is carried to a countershaft in a room devoted to the electrical machinery, and upon this shaft are fixed 12 pulleys, the belts from which drive the dynamo machines. The result of this combination is a remarkable steadiness of the lights, which burn for hours together without a sign of wavering. The electrical generators consist of 12 Bürgin machines. These are mounted in sets of three upon a framework of wood beams, along which they can slide, and their position upon which is fixed by set screws fixed to the framework, by which the tension of the belts can be adjusted as required. The first three machines are connected together in series, but so arranged that only two are actually in work. These are self-exciting, and the current from them is passed through the field magnets of the remaining nine machines all connected in series. The result is that these field magnets, all receiving the same current, and the armatures being all driven as closely as possible at the same speed, all the machines generate an equal electromotive force, and can be used to deliver their currents into the one conductor. The armature circuits are all connected in multiple arc.

The connections between all these machines are effected by a commutator system, which looks complicated, but is very simple, being composed of a circular block of wood for each machine, provided with three contact blocks, and a lever working on a central pin. At this point, therefore, each machine is under separate control, and can be cut out of circuit, or put in as required, either direct to the circuit, or through another similar commutator, by which the current from the machines simply or combined can be passed into a Siemens dynamometer. The whole working of this complex system of machines is thus kept under constant inspection, and any local derangement could be immediately discovered. The wires from the commutators are ultimately brought to screws upon a massive brass plate, which unites them all in one; a similar plate forms the commencement of the conductor to the Town Hall, and these two plates have a commutator at each end by which they are united, in the one case direct and in the other through a resistance composed of three iron telegraph wires fixed on the outside of the works, and of 250 yards in length. This resistance is employed when it is desired to send only half light into the lamps. The same might be effected by lowering the field magnetism, but in a temporary installation it is desirable to work as simply as possible, and it is obvious that the object of those concerned in the arrangement was to meddle with the machines as little as possible, but to arrange their connections and speed, and leave them unaltered during action.

The current has to be conveyed to the Town Hall through 500 yards of conductor, consisting of eleven cables (each containing seven No. 16 wires), enclosed in an iron pipe

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placed under the footpath of the streets. An exactly similar set of conductors is also used for the return circuit, so that the whole circuit is carefully insulated from earth, and as each cable singly would carry the current without dangerous overheating, it is evident no considerations of economy created any risk of fire. At the Town Hall these conductors are combined to form two circuits, eight are connected to one plate, from which they issue as one cable of nineteen No. 12 wires passing round the building with connecting wires at each window leading to the lights, a similar system carrying the return circuit. Another wire is carried under the gallery and into the *artistes*' rooms to work a distinct set of lights, which are frequently needed when the hall itself is not to be lighted. The nine machines are similarly divided in action, eight to the hall, and one to the minor circuit. The other two wires were not in actual use.

The hall is a building 135ft. long, 65ft. wide, and 65ft. high, with a narrow gallery running along each side, a large gallery at the entrance end, and, joining this, the orchestra rising up to and by the side of the noble organ, which itself reaches close to the ceiling. The lighting adopted consisted of groups of Swan lights suspended in sets of 12, like a bunch of grapes, from moulded brackets, which accorded well with the rich embellishments of the walls and the gilded ceiling. Over each lamp is fixed a shade, or translucent reflector of fluted glass in the Venetian style, of a blueish green colour, which greatly softens and diffuses the light. Sixteen such single brackets were evenly distributed along the sides, and 10, composed of two groups, were arranged on each side the orchestra and across the great gallery, so that the whole light was distributed from the sides of the building. Twenty-six two-light pendants were placed under the galleries, and two six-light pendants in the *artistes*' room, making 488 Swan lamps in the hall itself, and 500 in the building, which, with eight in the machine room, were worked by the system described, being about 46 to each machine, including the two exciters.

The following data as to the working of the machines were supplied by Mr. Lea, and relate to the steady working of the system when giving full light :—

EXCITING CIRCUIT.

Resistance 2 exciters in series, ohms	7·86
9 field magnets in series	15·7
	23·56
Current passing, amperes	20·4

WORKING CIRCUIT.

Resistance 8 armatures in arc, ohms	·274
8 line wires in arc	·158
Shunts and connections	·028
	·460
Lamps, 35 ohms while hot, 440 in series of 4 $35 \times 4 = 140 \div 110$	1·273
	1·733
Current passing, amperes	150·

The other circuit gear

Resistance 11·69 ohms, current 22· amperes.

The work done by the engine was not measured. The effect upon the ventilation of the hall was very curious, as the conditions were reversed. Under the usual circumstances a body of heated air collects under the ceiling (rising to a temperature of about 120deg.) and escapes through openings provided for the purpose, drawing in a fresh air supply through doors and windows. The result is, as every one experiences in such buildings, that the atmosphere becomes more and more oppressive the higher we go, so that the upper part of the orchestra is by no means an agreeable location. Upon this occasion the hottest and closest part of the hall was on the floor. After the performance had proceeded for two hours the writer went over the whole place, and found the best breathing conditions close to the ceiling at the top of the organ (which was not then in action). The temperature there was 74deg., while on the floor it was 78deg.

The effect of this was that the carbonic acid and moisture of the breath were not able to rise freely, as their slight extra heat did not overcome their greater specific gravity, and, therefore, they formed a stratum over the floor of the hall which was removed only by diffusion as the diminished air supply came in. But this did not place even this part at disadvantage as compared with other divisions, because the general heat was much less, and also the demand for air, because the ordinary lighting demands a supply of air somewhat greater than that needed by the audience. On the other hand, the orchestra and the organ were placed in greatly-improved conditions. Each of the occupants were provided with a paper, on which to express opinions as to the effect, and they unanimously concurred in saying that it was very much cooler and pleasanter, while some of the fairer portion intimated that they could see (and, which they did not specify, be seen), much better owing to the absence of lights in the middle of the hall. Some of them also added the very practical remark that there had not been a single case of fainting, such as always occurred before. Of course, the organ was greatly benefited, because the tuning is varied by temperature, as some of the pipes are much above others. As a concert proceeds there is produced a difference of a quarter note or more among them, while upon this occasion the whole instrument remained unaltered throughout.

Altogether the exhibition of the electric light and the incandescent form of it was a brilliant success, which must have given great satisfaction to, as it reflects the highest credit upon, all engaged in its production. The only thing to be regretted about it is that appliances so admirably fitted to the Town Hall and its uses should be removed. The Town Council certainly ought to purchase and retain them for future use.

We hope to furnish a view of the machine room and some further figures as to the work done in the lighting circuits upon another occasion.

EXHIBITION AT TYNEMOUTH.—The North-East Coast Exhibition of Naval Architecture, Marine Engineering, Coast Lighting Appliances, &c., was opened at Tynemouth on Wednesday last. The exhibition is held in the Aquarium, which, as well as the route to the building from the station, is lighted by Brush lamps supplied by the Hammond Company. Amongst other matters of interest to the electrical world will be found an exhibition of the application of the telephone to diving-bell work, by means of which all that is being done in the bell can be heard by those on board the boat in charge of it, thus saving time, trouble, and uncertainty. The idea originated with Mr. Wake, engineer to the Wear Commissioners, and was practically tried the other day, as mentioned in a Note in our last issue. It is interesting to note that, the greater the depth of water in which the bell is being worked, the easier it is to hear through the telephone.

A NEW TELEPHONE.—It is known to be advantageous to utilise both poles of a magnet in the telephone. How should the wire be placed, relatively to the magnet, to give the best effect is an important question. M. d'Arsonval has lately become convinced by experiment that in the two-pole telephones (as those of Gower, Siemens, Ader, &c.) the really active part of the wire is that lodged between the magnetic poles. The rest of the wire may be regarded as mere useless resistance. The point, then, is to have the whole coil between the poles. M. d'Arsonval, accordingly, makes a telephone with a bent bar magnet, one pole of which terminates in a short cylindrical piece, with a coil round it, while the other terminates in a ring piece surrounding the coil. These two poles are in the same plane, and very near the plate. The complete instrument is very light, yet it is said to transmit the voice with extreme distinctness, and with such force that, if a trumpet mouth piece be added, one can easily hear throughout a room.

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OPEN COMPETITION.

The statistics which we published in our last issue, extracted from the Civil Service Commissioners' Report for 1881, suggest some very curious, not to say serious, reflections. With the figures relating to the appointments of female clerks in the Post Office we have no concern, except in so far as they confirm the view we have always held with regard to any system of examination adopted as the sole preliminary to these and similar appointments. The self-denying ordinance which the Postmaster-General, of his own motion, saw fit to promulgate in the early part of last year, by which he disclaimed on the part of himself, and, it may be feared, every succeeding Postmaster-General, all rights to nominate persons for situations in the departments under his control, may or may not have been a highly moral act; and in regard to the superior appointments—amongst which that of female "clerk" must be numbered—it may have been a very convenient one. Where a good knowledge of English composition, geography, and English history, as well as of arithmetic and spelling, are required for the duties pertaining to the appointments, as seems to be the case of the female clerks in the Post Office, it would be highly undesirable that they should be filled haphazard by the Postmaster-General's nominees.

Nobody, however, desires that they should be so filled. The system of nomination might be retained without abandoning that of educational tests. Because the chief of the service, who is not a permanent official, and who admittedly is not the fittest person to nominate, declines the onerous patronage, it does not follow that nobody else should exercise it. The heads of the departments respectively where the the candidates are to be employed ought surely to have a voice in the selection; and, checked by a subsequent examination, conducted independently, there would be no danger of this form of patronage degenerating into systematic jobbery. As a matter of fact, the interested or indiscriminate patronage of individuals has now given place to "open competition," which, though perfectly disinterested, is as indiscriminating as the most reckless patronage could possibly be. Anybody and everybody are hauled into the Civil Service Commissioners' net, whose wide meshes are just as likely to land a heap of rubbish as to catch good fish.

This, broadly speaking, is the inherent defect of open competitive examinations, the one compensating advantage being that everybody has a chance, that nobody, from the highest to the lowest—to adopt the cant of the day—can complain that they are denied the opportunity of placing their valuable services at the disposal of the State. The wicked aristocrat can no longer exclude the virtuous plebeian from the cares, and spoils, of office. The machinery of the Civil Service Commissioners is no respecter of persons; it trustfully shuts its eyes "to see" what Providence will send, and we are all happy. Yet, not all. Of the 747 candidates who offered themselves last year for 76 female clerkships in Dublin, Edinburgh, and London, how many, we should like to know, would have been selected by the heads of departments at those places if they had been free to choose? Probably very few indeed, and of the 76 actually appointed still fewer. A porpoise is as big as a salmon, and quite as easy to catch, only we do not want it; and the officer who has to take anything the Civil Service Commissioners are pleased to send him is almost as much to be pitied as the hungry man who, longing for a juicy steak from the noblest of fishes, is served with a leathery hunk of the basest.

These obserations on open competition in general apply with especial force to the telegraph service. An educational test is here as obviously unsuitable as it would be for the fire brigade; not because education is unnecessary, but because other qualities are more necessary. This fact is recognised by the commissioners themselves, but in a peculiarly characteristic fashion. The examination is educational—that is to say, the whole and sole test is one of education, but of such a rudimentary kind that in these days of universal school boards it might just as well be dispensed with. The "male telegraph learner" and the "female telegraph learner" are, it would appear, no longer designated "clerks." Unlike "the female clerk in the post office" they are not required to write good English, to know the history of their own country, or the geography of any other. According to an advertisement which recently appeared in the newspapers, candidates for the telegraph service have only to do a few simple sums, and to write from dictation. It is not surprising that 448 females cheerfully faced this ordeal in June last, although the chances were more than ten to one against them getting an appointment. There were only 40 vacancies.

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It passes our comprehension how the examiners decided, even to their own satisfaction, whom to select in such circumstances. We may safely infer that, at least, 400 of these unfortunates ought to have passed—that is to say, they possessed the qualifications which the commissioners had declared comprehended all that is needful for the making of a telegraph learner. The process of sifting and weeding is, no doubt, very tedious and painful; and the net result is that the telegraph service gets a number of persons added to its roll who can do dictation and division, but who for all practical purposes might as usefully have been tried on the tightrope. If the educational standard were high there would be at least something gained; but, being what it is, the controllers of telegraph offices would, we strongly suspect, have preferred the acrobatic test, and taken their chance as to spelling and sums.

The illustration we have just made use of is not so extravagant as some people may think. What we desiderate is a selection made by persons competent to make it—using their eyes and their experience; and we say that this should be done previous to, or even in lieu of, the process which now does duty for both. Several qualities of first importance go to the making of a good telegraphist, and these qualities are only to be ascertained by personal inspection and inquiry. We do not pretend to say what those personal qualities are; we do not speak as experts; but everybody knows that they are indispensable, and the Civil Service Commissioners themselves cannot fail to perceive that they are not the people to discover them. As the Postmaster-General has relinquished the right to nominate—which was in truth the duty of nominating persons recommended to him by competent advisers—he ought to allow those advisers to exercise the function for themselves.

GENERAL LÜDERS.

We regret to have to record the death of General Lüders, Privy Councillor, and Director-General of Russian Telegraphs, which took place at Salbourg, on the 27th of August, at 8 a.m.

For more than fifteen years he has occupied the important post of chief of the Russian Telegraph Department. During this period he represented his Government at the International Telegraph Conferences of Vienna, Rome, and London. At the St. Petersburg Conference, in 1875, he was deputed to receive the other members on behalf of his country, and direct their deliberations. No doubt many of our readers will have cause to remember his hospitality and courtesy on that occasion.

By the death of General Lüders the Russian Government lose a faithful servant, whose energy and capacity will long be missed by those around him.

Electric Lights for French Lighthouses.—We noticed some time since that the French Government had authorised the application of the electric light in forty-two lighthouses on the coasts of France, at a total expense of £320,000. A sum equal to £6,000 has already been voted towards the undertaking, and the Minister of Public Works is about to demand a new vote equal to £28,000 for the continuance of the work in 1883. Cape Grisnez lighthouse and others down the Channel will probably be the first to receive the new light. It is estimated that it will take some eight or ten years to establish the electric light in the forty-two selected lighthouses.

BRITISH ASSOCIATION.

REPORT OF THE COMMITTEE ON ELECTRICAL STANDARDS.

The committee have to report that Mr. Taylor has continued the experiments upon the temperature-co-efficient of the resistance of metals and alloys, the first results of which were communicated at the York meeting. In consequence of Mr. Taylor's absence from the country the details of the further experiments cannot be communicated at present; but it may be stated that they have shown the possible influence of the powers of annealing on the specific resistance of wires and on the temperature-co-efficient to be much greater than has hitherto been commonly supposed. The following are examples of some results obtained:—

German Silver.—Wire drawn to be extremely hard and brittle. The percentage variation of resistance for 1deg., between 13deg. and 100deg. C., was 0·0296. After annealing, the percentage variation of the same wire was 0·0421.

Steel.—Wire 0·025 inch diameter, thoroughly hardened, and then tempered in paraffin wax at 230deg. C. Percentage variation of resistance for one degree = 0·267. Same wire annealed, percentage variation for one degree = ·316. At 9deg. C., the ratio of the absolute resistance of this wire in the hard state to that of the same wire when annealed was 1·229.

Platinum-Silver Alloy.—A piece of wire made from a particular bar of the alloy was hardened by being drawn down through a couple of holes of the draw-plate. In this state the variation of resistance was 0·0255 per cent. per degree. After annealing in the ordinary way, the variation of resistance was 0·0258 per cent. The same wire was next placed in an iron tube, which was filled up with sand, and left all night in the fire. After this treatment the percentage variation of resistance per degree was 0·0344.

Platinum-Silver Alloy.—Another specimen. A wire from a second bar of the alloy was annealed at a very high temperature and left to soak in the fire and cool slowly, as in the last-mentioned experiment. The variation of resistance was now 0·095 per cent. per degree, and the iron was as soft as pure silver and very fragile. After being heated to redness and quenched in water, the corresponding variation of resistance of the same wire was 0·076; and when the wire had been drawn down through two or three jewel holes it was 0·0732.

These results indicate a connection between the temperature co-efficient of wires and their degree of hardness, and tend to re-open the question as to the most trustworthy material for a permanent standard of resistance. The committee understand that Mr. Taylor will continue his experiments with the co-operation of Dr. Muirhead.

The committee are pleased to be able to report that there is a prospect that Lord Rayleigh may be able to organise, at the Cavendish Laboratory, Cambridge, a system of testing resistance coils and issuing certificates of their correct value at a specified temperature.

As stated in the report presented last year, Dr. Muirhead has consented, at the request of the committee, to issue standards of capacity upon his own responsibility.

The committee regret that they are not able to report any progress towards the construction of a standard of electromotive force.

They are unwilling to conclude without expressing their deep sense of the loss which not only they, but all friends of physical science, have suffered in the death of one of the most valued of their colleagues, Mr. Charles Hockin.

H.M.S. "Audacious."—This ship, which has just been commissioned, and will shortly proceed to the China station as flagship, to relieve the "Iron Duke," has had her machinery tried during the week at Plymouth. She is fitted with electric search lights and the dynamo machines necessary for producing the current.

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ELECTRO-MAGNETISM AS A PRIME MOVER.

[From an article in the *Practical Mechanic*, Vol. II., 1843, entitled "Prospects of Electro-magnetism as a Prime Mover, with a Notice of Mr. Robert Davidson's Electro-magnetic Locomotive, lately tried on the Edinburgh and Glasgow Railway," by David Mackie, C.E., &c.]

The dangers to which persons are exposed from the explosions of boilers while travelling in vehicles propelled by steam power, though now comparatively rare, still occur to such a degree as to render desirable the adoption of any other means of transit unobjectionable on that point, and which, at the same time, holds out the prospect of being equally economical and effective. To many the power derived from electro-magnetism may appear totally unworthy of consideration when they compare what has hitherto been done with the stupendous effects produced by the agency of steam; but it must be remembered that nearly two thousand years have elapsed since the first application of the vapour of water as a prime mover, and that it is only recently that the steam engine issued from the hands of Watt in a state admitting, apparently, of little improvement. Even one hundred years ago no person would have believed that there slumbered in a few gallons of water a power equal to that of hundreds of horses, and which, when applied to machinery, would, in defiance of wind and tide, impel the largest vessels to the remotest corners of the globe, raise thousands of times its own weight from the bowels of the earth, and propel trains of carriages with a speed which her fleetest coursers cannot equal. All this would have appeared to our forefathers as the ravings of a distempered or over-sanguine brain; and had the ridicule been effective which was lavished upon those who at first laboured to produce such results, advantages of incalculable value to society would either have been entirely lost or reserved for discovery by future generations.

In the application of electro-magnetism to the various purposes which at present occupy the power of steam, difficulties are unquestionably felt, and, when these are removed, others may start up, but this is no reason for altogether relinquishing the investigation of the subject. The discovery of these difficulties, and all attempts, however abortive, to attain the object, serve to strike out new paths, which must, sooner or later, terminate in its real attainment or force its abandonment, leaving at least the legitimate field of research more fertile and better defined. The circumstance of steam power having been a subject of frequent and serious investigation during the period of two thousand years, and, after having been abandoned innumerable times as hopeless, becoming at last triumphant, is most encouraging to those who may be engaged in a research affording such rich prospects as the application of electro-magnetism.

It is not much more than twenty years since the connection between electricity and magnetism was decisively verified by experiment, although such a connection had long before been imagined to exist, yet, within that short period, rapid advancement has been made in its application to useful purposes. The electro-magnetic telegraph, by which intelligence might be communicated from one extremity of Britain to another in the twinkling of an eye, is among the fruits of recent labours in this field of research, and, so far as trials have been made, the hope is not excluded that this new agent may yet become a powerful rival to steam. In point of safety its superiority is unquestionable, but it remains to be determined whether or not sufficient power can be obtained on equally economical conditions. The machinery requisite will, from the nature of power, be extremely simple in its construction and moderate in cost, rotatory motion being directly obtained, and the methods of reversing, accelerating, retarding, and terminating the motion requiring no additions which can materially detract from the original power communicated. The simplicity of the machinery also precludes the possibility of much friction, which it is well known absorbs no small portion of the power even of the best constructed steam engines. The great difficulties to be overcome are connected with the batteries, the materials of which stand in the same relation to the electro-magnetic machine that the fuel and water employed in working a steam engine do to that machine. Within the last few years great improvements have, however, been made in the construction of voltaic batteries, the augmentation of their power in proportion to their size, the permanency and equability of their action, and the economisation of the materials employed in exciting them. The physiological, chemical, and mechanical effects which could be produced by batteries of a given quantity of surface not above six years ago can now be equalled by the action of batteries of a tenth part the size.

This holds out very great encouragement to those who are engaged in the important task of applying electro-magnetism as a prime mover. After the discovery that a bar of soft iron having an insulated copper wire coiled round it became highly magnetic upon connecting the two ends of the wire with the opposite poles of a galvanic battery in action, the idea seems to have occurred to many scientific and practical men that a new and effective motive power was at their command. In December, 1832, Dr. Schulthess delivered a lecture before the Philosophical Society of Zurich, in which he asks "whether such a power as that which is obtained by interrupting the electric current and then restoring it could not be applied with advantage in mechanical science?" And in January, 1833, he exhibited before the Mechanics' Society a machine in which this had been, so far, accomplished. In November, 1832, Salvator Dal Negro, Professor of Natural Philosophy in the University of Padua, published a paper in which he explained the method adopted by him of applying electro-magnetism to move machines. Professor Jacobi, in the introduction to his memoir on this subject, states, "I had the honour, in November, 1834, to lay before the Academy of Sciences, of Paris, a note upon a new electro-magnetic apparatus. That note was read at the meeting of December 1, and an abstract of it was printed in the institute, No. 82, of December 3, to which I refer. Since that MM. Botto and Dal Negro have claimed the priority of the invention. The competition in which I find myself engaged with such distinguished men serves only to confirm my conviction of the importance of this new motive power." Jacobi continued his investigations with the utmost industry, and in 1838, under the auspices and at the expense of an imperial commission, he tried the grand experiment of impelling a boat by the agency of electro-magnetism. The vessel was a ten-oared shallop, equipped with paddle-wheels, to which rotatory motion was communicated by an electro-magnetic engine. In general there were ten or twelve persons on board, and the voyage was continued for entire days. The difficulty of their managing the batteries, and the imperfect construction of the engine, were sources of frequent interruption, which could not be well remedied on the spot. After these difficulties were in some degree removed, the professor gives as a result of his experiments that a battery of 20 square feet of platinum will produce a power equivalent to one horse, but he hoped to be able to obtain the same power with about half that amount of battery surface. The vessel went at the rate of four miles per hour, which is certainly more than was accomplished by the first little boat attempted to be propelled by the power of steam. The boat, according to Jacobi, was 28ft. long, and $7\frac{1}{2}$ft. in width, and drew $2\frac{3}{4}$ft. of water. The machine, which occupied little space, was worked by a battery of 64 pairs of platina plates, each having 36 square inches of surface and charged according to the plan of Grove with nitric and sulphuric acid. The boat, with a party of twelve or fourteen persons on board, went against the stream at the rate of three miles per hour. This experiment was tried in 1839, and shows what great progress had been made in the period of about one year, for in 1838, when the same boat was attempted to be propelled by the same machine, it required a battery of about five times the size. These particulars were communicated in a letter to Dr. Faraday by Professor Jacobi, dated 21st June, 1839, and may be seen in the *London and Edinburgh Philosophical Journal* for September, 1839. The publication of this letter called forth one to Dr. Faraday from Professor Forbes, of King's College, Aberdeen (dated October 7, 1839), in which, with a laudable desire for the

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honour of his country, Dr. Forbes gives a detailed account of the progress made by his townsman, Mr. Robert Davidson, in the application of electro-magnetism as a moving power.

At that period Mr. Davidson had in operation by this agent a turning lathe, and a locomotive carriage capable of running with two persons along a coarse wooden floor, and decisive evidence is given, that he had been employed for at least two years before in the construction of such machines. He had also made an improvement on Daniell's constant battery, and determined the best kind of iron for electro-magnetic purposes. The expenses of these experiments was entirely defrayed by Mr. Davidson himself, and although Dr. Forbes endeavoured to impress railway proprietors with the importance of aiding Mr. Davidson with the means of prosecuting his valuable and costly experiments, he was suffered to toil on till of late chiefly at his own risk. Last winter he exhibited in Edinburgh a saw mill and turning lathe, a printing press and locomotive engine, all worked by electro-magnetic power.

In this general sketch of the attempt to employ this new agent as a prime mover, it would be unpardonable to omit noticing the spirited efforts which have been made in the United States. So early as 1836, Mr. Devenport, then a blacksmith in Philadelphia, had turning lathes in action by this power; and in his noble determination to "go ahead" he commenced on January 18, 1840, a newspaper entitled *The Electro-Magnetic and Mechanics Intelligencer*. This paper, published at New York, was printed by a press worked by an electro-magnetic engine. We give from it the following extract:—

"The first number of the *Electro-Magnet* was published on Saturday, January 18, 1840, and was the first paper ever printed by the power of electro-magnetism. The project was proposed and set on foot for the express purpose of bringing before the public some tangible illustration whereby the power might be brought forward upon as cheap and prudent a scale as possible, the question having been so often asked, 'Why don't you apply the machine to this or that,' or anything that they in their wisdom might fancy, all of which we have duly considered. Therefore in following our own inclination, we have commenced as our own judgment dictates, and now offer to the public our plan of operation. As the second number of our publication is before the public, we would respectfully call the attention of those who would wish to advance the cause of philanthrophy, to come forward and assist us in our experiment. That we may be considered chimerical by many we doubt not, but when all things are fully proved we shall hope for a better fate than many of our predecessors."

Captain Taylor, of America, obtained a patent for an electro-magnectic engine in the United States, in 1838, and in England, he patented the same engine, on November 2, 1839. An account of this engine, accompanied by a drawing of it, may be seen in the *London Mechanics' Magazine*, vol. xxxii., p. 694, and a working model of it is now exhibiting in the Coliseum, London, where it is employed in turning articles in wood, ivory, and metal. Captain Taylor's machine is extremely similar to Mr. Davidson's working models, constructed about the same, if not at an earlier period. The method of cutting off and renewing the electric current is precisely the same. Much information relative to the principles upon which such machines ought to be constructed may be obtained from Jacobi's Report on the subject laid before the Academy of Sciences, St. Petersburgh, June, 1838, an abridgment of which may be seen in the report of the meeting of the British Association at Glasgow, in September, 1840.

It was only of late, as already remarked, that Mr. Davidson received any pecuniary aid in the prosecution of his interesting experiments. The Royal Scottish Society of Arts voted him last winter a few pounds to be employed in determining certain points connected with electro-magnetic machines; and several gentlemen undertook to defray the expense which might be incurred in the construction of a railway carriage capable of being propelled by the agency of electro-magnetism. This gave rise to the large and massive carriage which was last September tried on the Edinburgh and Glasgow line. As a description of this vehicle may be interesting to mechanics and engineers generally, I feel gratification in being able to supply it, and hope that, though brief, it will be sufficiently plain, accompanied, as it is, by illustrative diagrams. Those who have attempted the propulsion of machinery by electro-magnetism have proceeded on two plans somewhat different. It is well known that magnetic poles of the same name repel each other, and that those of an opposite name attract each other. Making use of this principle, then, suppose N (Fig. 1) the north pole of a magnet, and S the south pole (they may either be the poles of the same magnet of a horse-shoe form, or the N. and S. poles of two different magnets), and let *s n* be a magnet free to move on its fixed centre *c*; *n*, its north pole, will evidently be attracted by *s*, and *s* by *n*, so that the magnet *s n* will move in the direction in which it is attracted, and by its momentum or moving force will be carried beyond

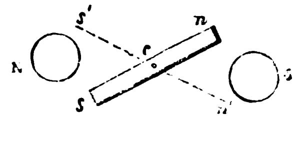

Fig. 1.

the points of attraction, S N, nearly into the position represented by the dotted line *n' s'*. Now, suppose that the instant it attains the position *n' s'* its polarity is changed, then *s'* will be repelled by S and *n'* by N; and the same conditions recurring, the magnet would evidently be rapidly carried round by the successive attractions and repulsions to which it is subjected. N and S are supposed to be the poles, not of a permanent, but of an electro-magnet, that is, an iron bar rendered magnetic by being coiled round with insulated copper wire, the two ends of which are connected with the opposite poles of an excited voltaic battery. The amount of magnetic power depends chiefly on the kind of iron, number of coils of wire, the size of the battery, and the strength of the liquids employed to excite it. Masses of soft iron have been rendered so strongly magnetic as to support more than

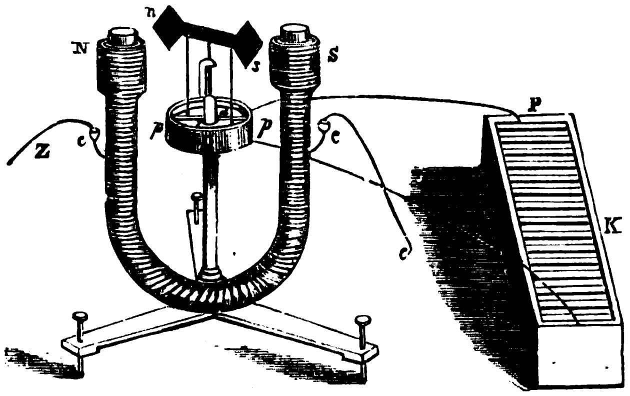

Fig. 2.

two tons. The bar *n s* is also supposed to be an electro-magnet, and its polarity may be reversed each time it passes the poles N S by a very ingenious contrivance of the late Dr. Ritchie, of the Royal Institution, London. To explain this we cannot do better than introduce the diagram of an apparatus in which Dr. Ritchie's plan of reversing the poles is made use of. It consists essentially of a cylinder of soft iron, having a copper wire, covered with thread, coiled round it (Fig. 2), the ends of which terminate in two cups, *c c*. If the wires Z C from the opposite ends of a voltaic battery in action be inserted into the cups *c c*, in contact with the other wires which terminate them, a current of electricity will pass along the coil and induce magnetism in the enclosed cylinder of iron. By similar means, the rod of soft iron *n s*, which is intended to revolve, is rendered magnetic, and we have now to direct attention to the manner in which its poles are successively reversed. It is

well known that a vessel may be rather more than filled with a liquid; that the liquid may be heaped up in it, assuming a convex surface, until the adhesion of the liquid particles is overcome by the force of gravitation. Taking advantage of this principle, Dr. Ritchie filled a cup, D, so that the ends of the wires proceeding from the coil on the revolving bar *n s* might almost touch the partition *p p*, which is made of a non-conductor of electricity, and divides

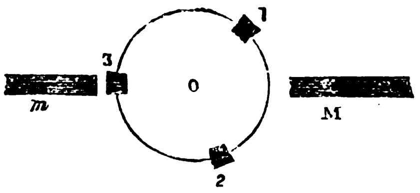

Fig. 3.

the cups into two compartments, *a b*. The compartments are heaped up with mercury, the partition being left uncovered, and connected to the opposite ends of a voltaic battery by the wires P and K, so that the one compartment may be viewed as the positive end of the battery and the other as the negative end. When the bar *n s* is in a straight

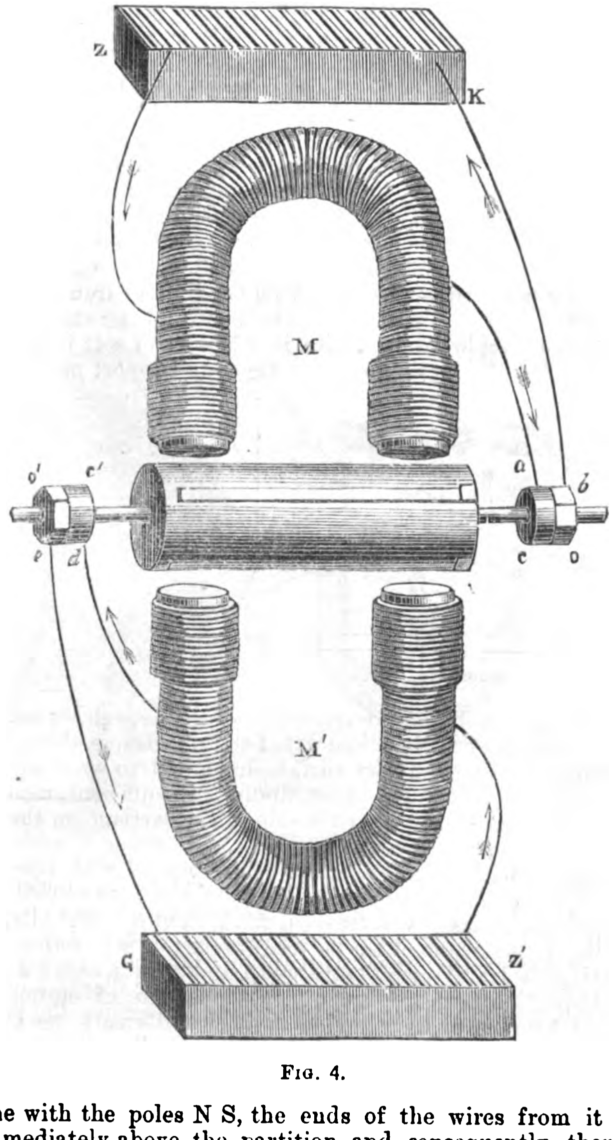

Fig. 4.

line with the poles N S, the ends of the wires from it are immediately above the partition, and, consequently, there is no current of electricity along the coil; but the moment the bar is moved to one side so as to make the wires dip into the mercury, and thus connect them with the opposite ends of the battery, a current of electricity passes along the helix on *n s*, and renders it magnetic. N repels *n*, while S repels *s*, and the bar moves round till N comes within the sphere of the attraction of S, and *s* within the attraction of N. The bar moves round until the wires are again out of the mercury, being above the partition, but in opposition to their former order. That instant the bar is demagnetised, and the next the wire formerly in *a* passes into *b*, and that in *b* into *a*, becoming again connected with the battery, but so as to send the electric current in the opposite direction and reverse the polarity of the bar. Instead of using only one fixed electro-magnet, it is evident that more might be used, and the revolving bar be thus subjected to a greater number of alternate attractions and repulsions. And should it be required to reverse the motion of the bar, we have only to make the wires P and K change places with respect to the ends of the battery. Such is the manner in which rotatory motion is produced, sustained, and modified in one class of electro-magnetic machines. At first view it would strike one that greater power could be obtained by using both the attractive and repulsive forces than by employing the attractive alone, yet Captain Taylor and Mr. Davidson, who have certainly paid much attention to the subject, seem to be of a different opinion, as they have adopted the latter method in all their machines.

They make use of electro-magnets to drag round masses of unmagnetised iron, contriving to deprive the magnets of their power, immediately after a mass has reached them, and again enduing them with power whenever a mass comes into a position favourable to its being attracted in the proper direction. What we have to premise, however, before giving an account of the construction of Mr. Davidson's electro-magnetic locomotive, will serve to render this plainer. As we do not think that the most complete drawing of the machine, unless it were of enormous size, could make the construction and mode of action so easily understood as references to diagrams explaining in detail the principles of its movements and their modifications, we shall adopt this mode of procedure.

Let there be a wooden cylinder (Fig. 3) of convenient diameter, and free to move on its axis, and let 1, 2, 3 represent the ends of masses of iron grooved into it, and M *m* two pieces of iron which we have the power of magnetising or demagnetising at pleasure. In the present situation of the cylinder suppose M to be magnetic, while *m* is not so, then M will evidently attract 1 more than 2; consequently 1 will be drawn towards M, carrying the cylinder round in that direction. If, when the middle of 1 has arrived very near the middle of M the magnetism is destroyed and *m* endued with magnetism it will attract 2, which by that time will be within its sphere of attraction. It is true that when 1 is immediately opposite M 2 and 3 will be equally attracted by *m*, but then the momentum which the revolving mass has acquired acts in conjunction with the force by which 2 is drawn towards *m*, so that the motion is continued in that direction, and as 2 approaches *m* the attractive force is rapidly increased, while that of *m* for 3 is proportionally diminished. By these means rotatory motion may be communicated to wheels the axle of which passes through the middle of the revolving cylinder. The next inquiry is, how are the bars M *m* to be magnetised and demagnetised at the instants required? Knowing that a bar of soft iron is rendered magnetic in virtue of a current of electricity passing along the wire with which it may be coiled, and that whenever that current is by any means broken the iron is no longer magnetic, it becomes necessary to fall upon some method of breaking the line of conduction and renewing it at will. Dr. Ritchie's method is beautiful and highly ingenious, but in applying electro-magnetism to the propulsion of boats or carriages it would not suit, as the mercury would be too much shaken, and sometimes even thrown out of the compartments of the cup or trough. Of course the method adopted in class experiments might be resorted to; that is, a person might be employed to break or complete the contact as the case might require, just as boys were formerly employed to open and shut the steam and injection cocks in Newcomen's engine. The beautiful contrivance of self-acting valves which now supersedes that irksome task is, perhaps, surpassed, at least in simplicity, by the method fallen upon by Captain Taylor and

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Mr. Davidson, of letting on and taking off the electric current, if we may be allowed this mode of expression. By means of the annexed diagram we shall be enabled to explain this contrivance, and, indeed, almost the whole that requires explanation in connection with this class of electro-magnetic engines. Let M and M′ (Fig. 4) represent two electro-magnets, by means of which rotatory motion is to be given to the cylinder between them, furnished with masses of iron, as formerly described. Near each end of the axle which passes through the large cylinder are two smaller cylinders. Each of these cylinders has the half of its rim next to the larger cylinder entirely covered with metal, so that it is a conductor of electricity. The outer halves O O′ are only partly covered with metal, the intervening portions being of ivory, well baked wood, or some other non-conductor of electricity. We shall suppose the dark spaces on the belts O O′ to represent the conducting parts, and the white spaces the non-conducting parts. Now, suppose one end of the wire which is coiled round the iron M to be connected to Z, one pole of a battery, and the other end of that wire, *a*, to rest on *c*, the metallic rim of the right hand small cylinder, while the wire K *b* from the other pole of the same battery rests on a metallic part of the rim O; in this case the circuit is complete. From the end Z of the battery the electricity traverses placed on each side of the large cylinder, through the middle of which the axle of the front wheels passes. The pair on the right and the pair on the left of the large cylinder act alternately on the masses of iron grooved into that cylinder, and communicate motion to the front wheels, the magnets receiving and being deprived of power in the manner already described. By the very same means, as the drawing indicates, motion is communicated to the hind wheels of the vehicle and locomotion ensured. The cylinders on which the arrangement is made for breaking and renewing connection with the batteries are, in Mr. Davidson's carriage, on the axles, beyond the wheels of the carriage; but we should think that, as they are a nice and important part of the apparatus, they would be safer within the wheels.

There are some points connected with the construction of separate and important parts of the vehicle which require notice; and, first, of the batteries. These are formed of pairs of iron plates, with an amalgamated plate of zinc interposed between each pair—a description of battery which Mr. Sturgeon, in 1829, found to be superior, in point of economy and action, in all cases where quantity without high intensity is required. The plates are 15in. deep and 12in. broad. There are four batteries, two at each end of the carriage, in all containing forty zinc plates. Each battery is arranged

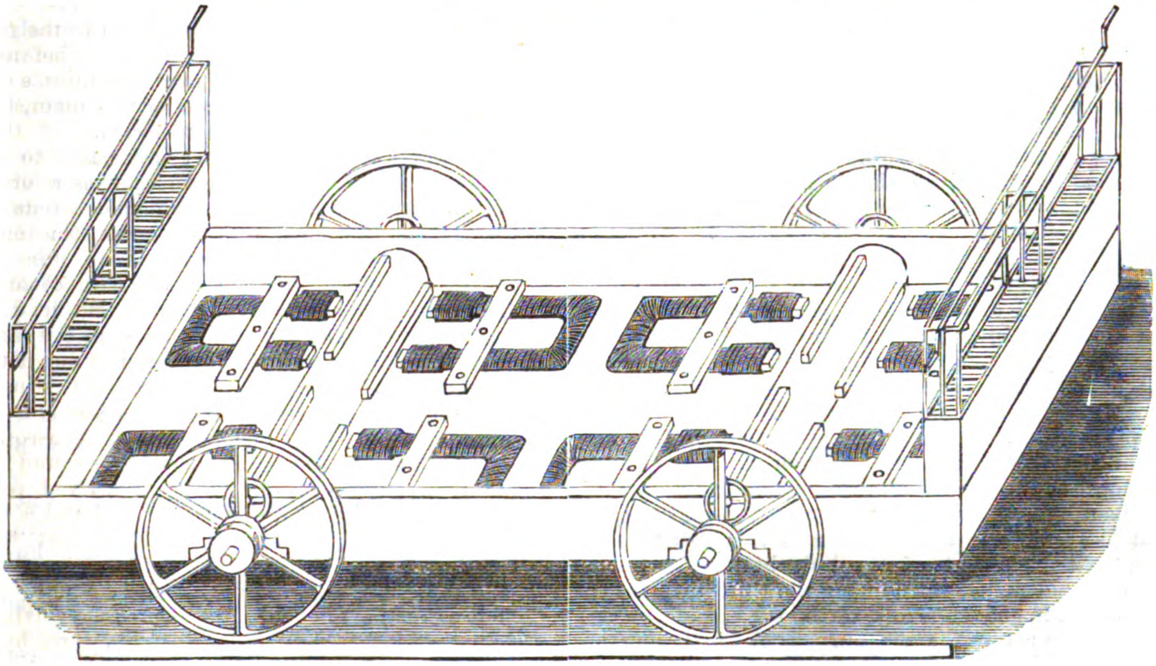

Fig. 5.—Davidson's Electro-Magnetic Locomotive.

the coil and the other connecting wires in the direction pointed out by the arrows; for the ends of the wires *a b*, though not in contact, rest on the same metallic surface. M is, therefore, an electro-magnet (in virtue of the current of electricity traversing its coil), and will be acting on one of the iron masses fixed on the large cylinder. By directing attention to the position of the wires *e d*, on the opposite small cylinder, it will be seen that *e* rests upon a non-conductor, so that the electricity cannot pass from *d* to *e*, or the current, which would otherwise traverse the coil on M′, is interrupted, and consequently M′ is not magnetic. As the cylinder revolves, *e* and *d* will at length both rest on the same conductor, and M′ will be magnetised; while, at the same time, a non-conducting part of the opposite cylinder will have reached *b*, and M will lose its attractive power. Such is the very simple manner in which the voltaic currents which traverse the coils are interrupted and renewed in order alternately to demagnetise and magnetise the enclosed nuclei of soft iron.

After the above details we trust that no one can fail to understand thoroughly the nature and construction of Mr. Davidson's electro-magnetic locomotive, a general representation of which is given (Fig. 5). The two batteries at the front of the carriage serve to communicate power to the four large electro-magnets nearest to them. A pair of these magnets is so that it can be raised from its wooden trough, or sunk in it, by means of a wheel and axle fixed in a frame above. The original extent of battery surface amounted to what we have mentioned, but Mr. Davidson, finding it insufficient, mounted an additional battery on each side of the carriage on the part of the platform between the wheels.

These batteries have 19 pairs of iron plates, with zinc ones intervening, all of the same size as in the former batteries. When the carriage was tried on the Edinburgh and Glasgow Railway, the whole of the batteries were put into action. The carriage is 16ft. long and 6ft. broad, and weighs above 5 tons, including batteries, magnets, &c. The rate of motion was about 4 miles per hour. The engineer will easily see that a fraction of a horse-power was all that was requisite to produce this effect on a level railway, and from knowing the work done by some of Mr. Davidson's smaller machines, we anticipated a much greater velocity with such an extent of battery. It is, however, among the first experiments on a grand scale, and we have no doubt will in time lead to much more gratifying results.

The electro-magnets are not one solid piece of iron, as is generally the case, neither are they rounded behind. Each of the side parts or arms is constructed of four plates of soft iron, put together so as to form, as it were, a box, for the sake

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of lightness. These arms are 25in. long, and joined together behind by plates of iron. Their rectangular poles measure 8in. by 5in. long, and at their nearest points are only about 4in. asunder. The coils with which they are surrounded do not consist of a single copper wire, but of bundles of wire wrapped round with cloth to ensure insulation. According to Mr. Davidson's first arrangement, these magnets were placed so that their poles were nearly in contact with the revolving masses of iron in their transit; but so prodigious was the mutual attraction, that the means taken to retain the magnets and iron in their assigned positions were insufficient. They required to be more firmly secured, and their distances had to be somewhat increased, by which considerable power was lost. The result of Professor Jacobi's experiments on the water, and of Mr. Davidson's on the railway, will, no doubt, disappoint the exaggerated expectations of some who may view them as rather unfavourable to the claims of electro-magnetism, but it must be kept in mind that it is only a few years since it in any degree engaged attention as a means of obtaining mechanical power, and, indeed, it could not have done so earlier, the connection between electricity and magnetism being so very recent a discovery.

Should it ever lead to the results anticipated from it as a prime mover, there are many advantages which it will possess over steam. The clash, din, and concussion occasioned by steam engine machinery, the dread of explosions, and the smoke, dust, and danger of fire would all be got rid of. The only noise in an electro-magnetic locomotive or boat would be that of the wheels, and the batteries could be charged in such a manner as to avoid all disagreeable smell. But even if the method of exciting them should be such as to produce hydrogen gas, this, instead of being permitted to escape and annoy passengers could be collected and rendered available as a means of producing light and heat when required. So far, however, as light is concerned it could be obtained otherwise at no additional expense; for a piece of charcoal being interposed at a small breach in the wires connected with the batteries would by its ignition afford the most intense and brilliant light imaginable, and furnish the means also of communicating signals to an immense distance.

We are inclined to think that the application of this new prime mover to navigation, particularly on the ocean, holds out better hopes of success than its application to locomotives on land. Iron vessels have now been proved well adapted for duty at sea, and since that metal and salt water constitute two important elements of a voltaic battery, may some means not be suggested of introducing the third element, so that a great part, if not the whole, of the surface of the ship may be called into action for the purpose of furthering her progress, thus making the ocean, so far, her propeller as well as support, while her own body also performed two important offices? Much less weight would also require to be carried by an electro-magnetic boat than by a steamer, and she could, therefore, undertake much longer voyages.

INFLUENCE OF THE POSITIVE ELECTRODE ON THE CHEMICAL WORK OF A BATTERY.

The name of M. Tommasi is well known to electricians for his researches upon electrolysis. One of his principal discoveries in this direction is the singular fact that the electromotive force or, to use an equivalent expression, the chemical work of the same voltaic pair varies according as the positive electrode is plantinum or carbon. A couple, for example, which is incapable of decomposing water, or a saline solution if its positive electrode is of platinum, will decompose the liquid in question if its positive electrode is of carbon. This fact having great importance in view of the relation between the calories, or quantity of heat disengaged by the battery, and the calories absorbed by the decomposition of the electrolyte, M. Tommasi has set himself to examine the fact, and his results were communicated by him to the French Academy of Sciences at a recent meeting.

A magnesium-platinum and dilute sulphuric acid element ought, according to thermic data, to decompose water. In fact, the number of calories disengaged by the action of the magnesium upon the dilute sulphuric acid (112) is superior to the number of calories of decomposition of H_2O (69). Nevertheless, the decomposition does not take place. It is the same if copper or silver is substituted for the platinum in the battery; but if a cylinder of graphite is employed, or, say, gas carbon, the electrolysis takes place.

According to M. Berthelot (*Comptes Rendus*, Nov. 7, 1881), two zinc-platinum couples in dilute sulphuric acid will not decompose a solution of sulphate of potassium. But by employing two zinc carbon couples and dilute sulphuric acid, M. Tommasi has been able to electrolyse a saturated solution of sulphate of potassium with very strong disengagement of gas at the two platinum electrodes with transport of the acid to the positive electrode and of the base to the negative electrode, and that at the end of a few minutes, under ordinary temperatures. According to M. Berthelot 103 calories are necessary to electrolyse a solution of sulphate of potassium, whilst M. Tommasi obtains that decomposition with 76 calories and even less, for it is produced by two zinc carbon and dilute hydrochloric acid either with 69·8 (calories disengaged by the action of a molecule of amalgamated zinc upon dilute hydrochloric acid). A single zinc carbon couple and dilute sulphuric acid decomposes the sulphate of potassium if the electrode of the voltameter is of copper, but does not decompose it if the electrode is of silver.

M. Tommasi has submitted various salts to electrolysis. The saline solutions contained an excess of salt. The platinum wires of the voltameter had a diameter of 0·4 millimetres, and plunged into the liquid to a depth of 0·3 to 0·4 metres. The carbons were of Siberian mineral graphite or gas carbons first heated red hot and cooled in corked flask containing air, nitrogen, or still better, carbonic acid. The presence of this gas in the pores of the carbon is only intended to retard polarisation, and render the effects to be of longer duration.

The results are given in the following table, the battery consisting of two zinc carbon couples in dilute sulphuric acid = to 77·4 calories.

Sulphate of magnesia (disengagements of gas at both electrodes) 108*
" Zinc (negative electrode ÷ zinc. Positive electrode ÷ oxygen) 114*
" Cadmium (negative electrode — cadmium. Positive electrode — oxygen) 92*
" Copper (negative electrode — copper. Positive electrode oxygen) 65*

[Two zinc — platinum couples and dilute sulphuric acid decompose also sulphate of copper; but a zinc — platinum couple + a Regnault couple does not decompose sulphate of copper, whereas a zinc — carbon couple + a Regnault couple does decompose that salt. With regard to the cadmium element, it should be remarked that Berthelot gives 147 calories as the figure required to produce disengagement of oxygen at the positive pole and a deposit of cadmium at the negative pole.]

Sulphate of manganese (negative electrode — hydrogen and manganese. Positive electrode — binoxide of manganese, but no oxygen) .... 116·1*

[After Berthelot, three zinc platinum couples (116 calories) will give electrolysis, but no deposit of manganese or the negative electrode. With three zinc-carbon couples M. Tommasi also observes a disengagement of oxygen or the negative electrode. With a single couple he has produced decomposition, but very feebly.]

Sulphate of iron (negative electrode — hydrogen and iron. Positive electrode nothing) .... 116·1*

[Oxygen is absorbed by SO^4Fe. A single zinc carbon couple suffices to decompose the sulphate of iron, but in this case

* Calories or Electrolysis after M. Berthelot.

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there is only a disengagement of hydrogen at the negative electrode without a deposit of iron.]

Chlorite of potassium (negative electrode — hydrogen and base. Positive electrode — little or no disengagement of oxygen) 92*

[The liquid of the positive branch of the voltameter is yellow in colour, reddens at first, and afterwards discolours litmus blue.]

Bromide of potassium (negative electrode — hydrogen and base. Positive electrode — bromium) 80*

[The yellow colouration of the positive branch of the voltameter is due either to oxides of bromium or to perbromide, as has been observed by M. Berthelot.]

Iodide of potassium (negative electrode — hydrogen and base. Positive electrode — iodine) 54*

[A zinc — carbon element decomposes quickly the iodide of potassium with deposit of iodine at the positive electrode, and disengagement of hydrogen at the negative electrode. A zinc platinum element with dilute sulphuric acid also decomposes, although more feebly, the iodide of potassium. After M. Berthelot a zinc platinum couple will not decompose iodide of potassium. It is probable that M. Berthelot operated on a solution of iodide of potassium too extended, and in this case his electrolysis ought to produce itself less easily. In fact, the iodide of potassium absorbs, in order to be decomposed, fewer calories than water, and, consequently, the more concentrated the solution the easier to decompose it.]

In offering some criticism on M. Tommasi's results, M. Berthelot, the distinguished chemist, expressed the opinion that a zinc-carbon couple cannot be regarded as the equivalent of a zinc-platinum couple in the calculation of the quantities of heat developed by reactions which give birth to the voltaic couple. In fact, the heat disengaged by the attact of the zinc and acid is not the total with carbon, which exercises reactions proper and peculiar to itself. It absorbs hydrogen, oxygen, and these bodies interfere with the pure action of the carbon, as has been demonstrated by the researches of M. Ed. Becquerel (*Ann. de Chimie et de Physique*, 3rd series, Vol. 48, p. 256) on the electromotive force of such couples. He also points out that the thermic values which express the electrolytic reaction are only established for dilute liquids, and that the effects due to the separation of a trace of acid from the base in saturated saline solutions cannot be rigorously calculated because of the changes of concentration and secondary reactions. The principles of the calculation are the same, but the data fail. In reply to M. Berthelot, M. Tommasi points out that he has shown that with two zinc carbon couples and dilute sulphuric acid, it is possible to decompose a solution of sulphate of potassium when that decomposition cannot be effected by two zinc platinum couples and water accidulated by $SO^4 H^2$. This experiment has been repeated by him with solutions of sulphate of potassium of strength varying from 1 per cent. to saturation, but no appreciable difference was observed in the electrolysis of these solutions. He also points out that even if there were metallic impurities in the carbon they would only serve to increase the difference of potential between the two extremities of the circuit. As to the substitution of pure carbon for platinum in a zinc-platinum couple with water accidulated by $SO^4 H^2$, M. Ed. Becquerel has already observed, in 1856 (*Ann. de Chimie et de Physique*, 3rd series, Vol. 48), that the electromotive force of this couple diminishes instead of increasing. M. Tommasi further thinks that the increase in E.M.F or carbon couples is not due to the absorption of hydrogen or oxygen by the carbon, for, as he has already observed, to obtain good results with these couples it is necessary that the carbons should enclose in their pores a gas, carbonic acid, for example, which, by its presence, forbids, or, at least, retards, the polarisation of the positive electrode of the battery. At the same time, he does not deny that the absorption of certain gases by the carbon is not the cause of the increase of energy of carbon couples, but he does not consider such a supposition justified by experiment.

* Calories or Electrolysis after M. Berthelot.

THE EDISON SYSTEM OF ELECTRIC DISTRIBUTION.

BY F. J. SPRAGUE, U.S. NAVY.

I do not propose to enter into any discussion as to the priority of the claims of this inventor as compared with any other, but to speak of Mr. Edison's system as it has appeared to me after a thorough investigation and study of the same, extending over several months, and with great facilities at my command; and my conclusions are based, not on Mr. Edison's claims, or the claims of his friends, but are the result of a candid examination. Mr. Edison's ambition has been far reaching, and he designs to establish a system of distribution, not alone for lighting, but for almost every purpose to which the electric current can be put, and he recognises the all-important principles, that all parts of such a system are mutually dependent; that thorough mathematical and engineering talent must be used; that no detail is so unimportant, no real objection so trivial, but that it requires patient consideration; that dynamos, meters, lamps, motors, conductors, districts laid out, capital invested, and energy wasted, must all be calculated with reference to each other—in short, that economy and reliability are the great ends to be attained. The result is, that he comes now before the world, after three years of hard work and patient experimenting, feeling fully equipped and able to establish thoroughly reliable and extensive installations. I have stated some of the requirements of a system of general distribution, and will consider that with Mr. Edison in detail and as a whole. I shall not give a full description of all the parts, but intend rather to consider it from a practical and economic view.

In the first place, let me speak of the

Dynamos.

These generators, which have armatures wound or connected on a modification of the Hefner-Alteneck system, may be divided into three classes:—

1st. Those having wire-wound armatures, the coils being wound on a wooden cylinder wrapped with a soft iron wire. These armatures are driven by belting, and rotate between the faces of long, vertical magnets at a speed of from 800 to 1,200 revolutions per minute, according to the size of machine and the number of lamps. By using a large mass of metal a powerful magnet may be created, rendering necessary a less number of convolutions of wire, and, consequently, less heat and waste in the armature for a given electromotive force. By using long magnets the mean resultant of the convolutions of wire is brought much nearer the centre of the core than would be the case with the same weight of metal and a shorter length. On account of this a more active magnetic field is produced; one with a greater projective power, and less current may be used in the field coils. This can be exemplified in a striking manner by reforging the cores with the same amount of iron, but making them shorter, and rewinding with the same amount of wire as is now used. With the same speed of armature and the same number of convolutions, the E.M.F. of the machine will fall very appreciably, and this lower E.M.F. can be obtained by using the longer magnets with the faces at a much greater distance from the surface of the armature. The commutator is long; its life, or time of running without repair, is thus increased, and should a movable commutator be fitted the trouble of taking care of a machine may be reduced to a minimum. There are four varieties, or classes, with capacities of 70, 150, 250, and 500 lamps, and the number of magnets depends upon the size of the machine. Each pair of cores is in series; if two or more pairs are used the pairs are thrown in parallel circuit.

Roughly speaking, the resistance of the field coils may be expressed by the fraction $\frac{3,000}{L}$, where L is the full number of lamps. In the 70 lighter this resistance is 40·4 ohms cold, and 41·5 warm, and the field is in parallel circuit with the external circuit. The machine generates an E.M.F. of about 110 volts, and runs very quietly. Ordinarily 60 lamps would be the proper load if running for a long time, but 85 can be readily carried for a shorter period. The only limit to the power of a machine, ordinarily speaking, is the heating of the armature, which depends upon the total volume of current flowing. The armature has a resistance of ·16 ohm, cold, and ·20 warm. With a difference of potential of 100 volts at the terminals, the field coils would require 10,650 foot-pounds of electrical energy expended per minute, or ·32 horse-power, represented by about a pound of coal per hour. The energy lost in the armature would be C^2 8·848, C being the total current in amperes. With a circuit of 70 140-ohm lamps, the external resistance, including the field coils, but not the conductors, which are very low, would be 2 ohms, over 9·5 times the internal. Reference to the curve shows it to be very flat at this point, and the change in E.M.F. of the machine for a large reduction of lamps would be

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small. If the number be cut down to half, the drop in the E.M.F. would be but about 4 per cent. My experience with the larger capacity machines of this type does not warrant me in commenting on their performance, but from the knowledge of their construction I should judge their efficiency to be about the same. I should have said that about 9 or 10 horse-power should be delivered to the pulley of the 70-light machine.

2nd. The second class comprises machines with long magnets, as in the first, which may be coupled in series, or in parallel circuit making their resistance about one-fourth, and enabling a given E.M.F. to be obtained with a lower speed. The armature is built up of iron discs, and has a sheathing of copper bars connected across the ends by copper discs. One pair of bars and one pair of discs form a complete coil. This armature is of very low resistance; in the ordinary size it is one-tenth that of the armature of the 70-lighter. It is run at about the same speed, develops a lower locomotive force, and is suitable for lamps of lower resistance. One of these machines was very carefully tested by Mr. J. A. Howell, at Stephen's Institute, and no better idea can be formed of its efficiency than by reference to the following table, which is compiled from *Van Nostrand's* January magazine. Three tests were made, and all sources of error were eliminated as far as possible. The first was by means of the voltameter, the second by calorimeter, and the third by the E.M.F. and resistance method. By "efficiency" is meant the ratio of the total electrical energy developed to the power required to turn the armature in the magnetic field. By "commercial efficiency" is meant the ratio of energy appearing in the external circuit to the power required to drive the machine, including friction.

Data.	1st ex.	2nd ex.	3rd ex.	Average.
Time of duration	15·	16	—	—
Speed of dynamometer	400·5	394	355	—
Resistance of armature	·016	·016	·016	—
Total resistance of circuit	·773	·696	·658	—
E.M.F.	64·74	55·10	53·00	—
C.	83·75	79·17	80·55	—
Efficiency	·955	·967	·935	·951
Commercial efficiency	·861	·901	·87	·887
Foot-pounds of electrical energy:—				
Appearing in armature	4965	5604	5026	—
Field coils	4646	4216	3347	—
External circuit	230268	233940	198301	—
Per centage of same appearing:—				
In armature	2·07	2·30	2·43	2·27
Field coils	1·94	1·73	1·62	1·73
Both	4·01	4·03	4·05	4·03
External circuit	95·99	95·97	95·95	95·97

Little comment need be made on these results. With a similar machine, the field magnets in parallel circuit, 240 8-candle lamps of about 65 ohms resistance have been run. These armatures are somewhat difficult of construction, but it seems to me that their efficiency is so remarkable that the extra expense is warrantable, and I should like to see more machines constructed on this rather than on the wire principle.

3rd. This class comprises machines with armatures on the same plan as the last, but very much larger, of lower resistance, and of double the electromotive force. The field magnets are horizontal, have 12 cores, and their resistance is about one-seventh that of the 60-lighter. The armature is connected directly to the engine, this being a well-powered, high speed, non-condensing engine, known as the Porter-Allen. The governor controls the throw of the valve by shifting the position of the link. The armature has a speed of from 280 to 340 revolutions per minute, the ordinary speed being about 300. There are in Europe three only of these machines, the first being in Paris, the second and third at the central station at Holborn-viaduct. These are not of the same size, No. 3 being the largest, and having capacity normally of about 1,000 lights. I think six others have been constructed, part of which have already been tested for the New York lighting station. The resistance of the armature of No. 3 when cold is ·0038 ohm, this low resistance being obtained by the use of a few large conductors. The connections are plated with gold to prevent oxydisation. Although the normal capacity of No. 3 is about 1,000 lights, it can be readily run up to 1,200 or 1,300, and by coupling the field magnets so that their resistance is about 4-9ths that of the Holborn-viaduct machine, Mr. Edison very recently ran 1,630 lamps at 20 candle-power. Of course, on account of a certain amount of loss in the conductors of a general system, a generator must be able to develop an E.M.F. of from 10 to 20 volts more than difference of potentials existing at the lamp terminals. I have been informed, on reliable authority, that the No. 3 machine was tested before leaving New York with 1,320 lamps for fifteen consecutive hours. I suppose this was at 16 candles. Referring again to Howell's experiments, we find that one lamp of 140·5 ohms resistance required, for an illuminating power of 16 candles, a potential of 99 volts, and used 3,107·41 foot-pounds of energy per minute. The potential and resistance give a current of ·7046 ampere. This is about the average of five lamps, and we may base some calculations on this. 1320 lamps would require 930·072 amperes, and the external resistance, that of the lamps, would be ·1064 ohm, or 28 times the internal. Call the resistance of leading wires ·01 ohm, *i.e.*, one-tenth of the lamp resistance, which will give a lamp circuit resistance of ·1164 ohm. The resistance of the field coils, cold, is 6·73 ohms, which, in parallel circuit with the lamps, gives an external resistance of ·11425 ohm, and a total circuit resistance of ·11839 ohm, allowing an increase of 5 per cent. for the resistance of the field coils, and 10 per cent. for the armatures. For convenience, I regard the leading wire resistance as entirely entering between the commutator brushes and the lamps. This will give a difference of potential at the brushes or terminals to the field coils of 108·05 ohms, and a field current of 15·29 amperes; whence we have a total current in the armature of 945·36 amperes, and an E.M.F. of 111·67 volts. This gives an equivalent of 73,090 foot-pounds in the field coils, 387,200 in the leading wires, 163,690 in the armature, and 4,064,050 in the lamps, making a total of 4,688,030 foot-pounds of electrical energy per minute. In the absence of exact data, let us suppose the efficiency of this machine to be the same as, or rather let us say that it is 2 per cent. less than that of the small machine we were before considering, *i.e.*, 93 per cent. There would then have been applied 5,040,892 foot-pounds per minute to the axis of the armature, or 152·75 horse-power, of which there was expended 123·15 in the lamp circuit, 11·73 in the external conductors, 2·22 in the field circuit, 4·96 in the armature, and 10·69 otherwise wasted; or, expressing it in per centages, 80·6, 7·6, 1·5, 3·3, and 7·0 per cent. respectively. Although 4·96 horse-power may seem in itself a large amount to be lost in the armature, it is, we see, a very small per centage of the whole, yet a diminution of ·0001 ohm would diminish the loss by 3,916 foot-pounds per minute. We thus see how absolutely necessary it is to have the lowest possible resistance in the armature when dealing with large currents, the energy of which, expended in a circuit of given resistance, increases with the square of the current. Suppose, for a moment, an armature were built of the tenth of an ohm resistance, and the same current 945·36 amperes were to flow through it, there would be a loss of 118·6 h.-p., and with the resistance of an ohm the power of 1,186 horses, or 19,569 foot-tons per minute, would be lost; in fact, it would be practically impossible to build an armature of that resistance to sustain the current.

Another rather instructive calculation may be made by reducing an armature to a nominal equivalent foot conductor. In this it is not necessary, in order that we may compare with another machine, to consider the relative intensities of the field. All machines have certain parts of the conductors which are inactive, and the less this proportion the better for the machine and the higher efficiency will it show. In this generator there are 98 bars on the armature, the average length being 4ft. 9in., of which 4ft. 2in. are active. The circle of revolution is 27·5in. diameter. At each end are 49 circular plates, each of which I consider the equivalent of a conductor 27·5in. long, and having a velocity of a point at half distance from the centre. I think that the speed of the engine was about 320 revolutions, because with a load of about 700 lamps its speed is 290 to 300 revolutions. I feel quite certain that it was not above that. With this data, I find the active part of the armature to be equivalent to a conductor one foot in length, moving with a velocity of 15,682ft. per second, and the inactive part, comprising the ends of the bars and the discs, equal to a foot conductor with a second velocity of 6,507ft., or the whole equivalent to a foot conductor with a velocity of 22,189ft. per second. With an E.M.F. of 111·67 volts, this gives a foot conductor a second velocity of 198·7ft. per volt developed, and with 5,040,892 foot-pounds per minute an absorption of 3·78 foot-pounds in a foot conductor per foot per second, of which 93 per cent. is developed into electrical energy. This is an admirable showing, and affords some data on which to build a still larger machine. I am inclined to think that, were the armature built up of rings instead of discs, even less power would be wasted, and the machine be in every way probably as efficient. But there is a limit to the size of machines to be built, which limit is reached when we determine how much waste can be afforded, and how much must, of necessity, be lost in the armature.

The current generated is taken off by four pairs of independent brushes, the surface of the commutator being slightly amalgamated. The sectional area of the brushes on one side is about four square inches. Unless adjusted carefully, there is a good deal of sparking, and consequent loss in wear, but experience, in a little while, enables one to set these brushes

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sufficiently far ahead to make this almost entirely disappear. The scoring of the commutator in a four months' run, which has been, to a great extent, experimental, is about ⅛in. The commutator blocks should be movable, and I understand that all large machines are now so constructed. I have seen the largest machine here run one lamp at about 16 candles, and at other times 800 to 1,000 at from 20 to 25 candles. Of course there is no economy with a few lamps on a machine of this size. The potential is such that the commutator brushes can be readily grasped, but there is a peculiar sensation of heat experienced in the wrists and forearm. The armature heats moderately, the radiation being hindered by a thorough insulation, but a blower forces air around it to prevent undue rise of temperature. As interesting experiments, the two machines at Holborn-viaduct have been joined in parallel circuit, although of unequal capacities, and a sixty light machine could be just as readily coupled to the same circuit. One machine has been stopped, the circuit broken, and the load taken by the other generator, all in about twenty seconds. One machine has been stopped, and the load thrown on the other without extinction of the lamps; and once the engineer, by a mistake, kept throttling one machine down, because he thought it was running too fast, to find that this machine was being run as a motor by the other.

The engine seems to me to be an excellent one, and now that opposition in some quarters to large dynamo machines has been hushed, the engine becomes the moot point. The general experience has been that high speed engines, on variable work and long runs, have given a great deal of trouble with lost action, back lash, loosening nuts, and wear of piston, cylinder, valves, and guide bars. In a large system of distribution, the variation of load is not the same as in a tool shop or factory. It will be generally much more gradual, and consequently the work is better adapted for a high speed engine than many other kinds might be. On behalf of large engines there may be urged less wear and tear, fewer individual parts to look after, less liability to a break down, a greater number of good engines to choose from, and higher economy. On the other hand, there is, in favour of the higher speed engine, less boiler space required, the size engine for a given power being so much less, the individuality of each engine, the less inertia, and in case of a break down the disabling of a much smaller part of the plant. I confess to have had a prejudice against high speed engines, but this has mostly disappeared, and an inspection of one of the engines in use at Holborn-viaduct shows it to be in thoroughly good condition. I believe that Mr. Edison has another engine under trial, and that he is not committed to the present one. Why the change will be made, if such there is, I do not know, unless because of greater regularity.

The boilers are the Babcock and Wilcox patent, adapted for quick steam and high pressure. They need to be well taken care of, but are widely and favourably enough known to engineers to need no comment on my part.

Lamps.

On account of the need of having the external resistance high compared with the internal—and this ratio necessarily increases with the volume of current required; the resistance entering into a part of the lamps, and not into others; the necessity for allowing but a small variation of illumination in different lamps; and from the fact that a given illuminating power can be obtained from a fine filament with a less loss of energy in conductors than from a coarse one, Mr. Edison has aimed at carbons of a very high resistance. There have been difficulties in the way by no means easy to surmount, a fact with which all inventors of incandescent lamps are probably conversant. One is that carbon diminishes its resistance when hot, another that strength, elasticity, and life are wanted. A third is that lamps of like illuminating power should have the same resistance, and the certainty of a reasonable life. Remarkable advance has been made, and 16 candle-power lamps are now made of 240 ohms resistance cold, dropping to 135 to 145 hot, and 10-candle lamps of about 475 ohms cold, and 275 hot, exceedingly strong and elastic, and of long average life when used at the proper power. This life is still quite variable, and it cannot be foretold. They may not last 300 hours, they may last 2,000. About 1,100 hours is their average life at present. Made of the finest bamboo, they are fibrous, of very even texture, and very fine; yet I have split, accidentally, the carbon of a ten-candle lamp. There is another variety, the eight-candle lamp, which is called the "B;" this is of the same cross section, and one half the length of the "A" lamp, but its use is limited, because in a general system, absolute individuality of all lamps is a requisite. The carbons are joined to the copper terminals of platinum wires in the glass, the copper clamps and ends of the carbons being plated in a solution. The platinum wires are sealed in a hot pressed joint, at the inner end of a tube sealed in the neck of the globe, whence copper wires lead to brass connections, which are brought into contact with the similar connections in the socket. One contact is made before the other can be, and this last is by firm pressure. The carbons are so elastic that they will vibrate from one side of the globe to the other, and keep up a rapid vibration for a long time. When hot they are less elastic. To get lamps of higher illuminating power, the width of the carbon is increased, while the thickness remains about the same. Two or more carbons have been used, but this is not a practical arrangement. This gives about double the illuminating surface, half the resistance, and requires double the energy. There is room for great improvement in the matter of lamps of high power, for I have no doubt in the near future that incandescent lamps of 200 or 300 candle-power, and even higher, will be perfectly practicable. It has been said that lamps should have the highest possible resistance. This is not so. The carbons have been reduced about as far as possible in width. It is possible that they may be made thinner, and in this way a step made to lighter weight, higher resistance, and greater economy. But the real limit is the potential which can be used. The resistance of a carbon of given illuminating power must depend upon the foot-pounds of energy expended, and the potential at the terminals. I append the following table, which will give the required lamp resistance at different potentials, and with varying degrees of economy, in the case of a 16-candle lamp, which candle-power we will suppose remains the same. I will begin with the economy already obtained, about 3,000 foot-pounds per minute per lamp.

Foot-pounds of E.E. used in lamp per minute.	No. of lamp per E.H.-P.	Candles per E.H.-P	Resistance of lamps in ohms when the E.M.F. is (volts).				
			100	125	150	175	200
3,000	11	176	147	246	332	452	590
2,500	13·2	211·2	177	293	398	542	708
2,000	16·5	264	221	367	498	677	885
1,500	22	352	295	489	664	903	1,180

Already there has been produced about 12 lamps per E.H.-P., and, although I hope to see it reduced, I think that 2.000 foot-pounds of energy is as low as can be hoped for, and I do not feel we should go above 150 volts potential at the lamp terminals. If this end can be obtained, the carbons must have a resistance of 498 ohms, hot, and there will be produced over 260 candles per H.-P. of electrical energy. I am confining these computations and statements to the case of lamps not giving over 16 candles each—about the standard of which a long use of gas has led to the adoption. Of course, with higher illumination per unit of area, a greater given power per coal expenditure can be had, but is attended with a shorter life.

The difference in work for a 140 ohm lamp at 15 and 16 candle-power is about 84 foot-pounds. Referring to the lamp already considered, and the equation of work, we find that at 15 candle-power there can be an additional circuit resistance of two ohms in one of two lamps, which is about one mile of No. 8, or 1,000 feet of No. 15 copper wire. With a higher resistance lamp this circuit resistance can be increased. Neither a high resistance nor a high potential is necessary to get a certain candle-power with a certain expenditure of energy in a lamp of given mass, but a greater current is necessary with the lamp of low resistance. This means a greater loss in the conductors, a less efficiency of generator, and a much more limited distribution. Let me illustrate by a particular instance.

Suppose a system in which about 500 lamps is supplied from the central station by a cable an inch in diameter. If this conductor is not insulated, but is open to the air, the current is sufficiently strong to raise the temperature very appreciably, say 15 deg. Centigrade. Now, what are the conditions under which the main supply cables of a large system of distribution are laid down? One condition is that they must be thoroughly insulated, and, if so, then the free radiation of heat, although surrounded by moist earth, is prevented; consequently, the rise of temperature will be fully as great as in a cable open to the air. Suppose with the same number of lamps double the current is used. Now, if the resistance of the cable remains the same, four times the work will be done, four times the number of heat units will appear, and, since the heat radiated must be equal to the heat generated, the temperature will rise until the difference of temperature between the cable and the earth is four times that which existed in the first instance. But what are the conditions now? Copper increases its resistance with the rise in temperature, this increase being about ·4 per cent. for each degree Centigrade, and if our rise in the first instance was 15 degrees, the resistance now has increased some 30 or 40 per cent. Therefore, instead of four times the work being lost on the conductors, there is something more than that, say five or six times, and, furthermore, the temperature of the cable is now dangerously high for the insulation.

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Meters.

After many trials of various kinds of meters or registers, Mr. Edison has adopted that which depends on electrical deposition, and has selected pure zinc for his plates, a strong solution of sulphate of zinc for the liquid, and places the register in a shunt circuit, allowing about 1-800th of the current to pass through it. The weight of zinc deposited in one hour by one ampere of current is 1,198·8 milligrammes. This, of course, gives a means of determining the amount of current used, with little loss in the registering apparatus. Polarisation is remarkably weak, and there is very little variation when a large number of them are tested together. Very careful weighing is necessary, and, probably, the popular desire to see for one's self what current one is using, and thus have a check on the readings of the company, could only be met with this meter by having a competent supervisor of the weighing who was in no way connected with the company. But in the meter economy and accuracy seem to have been the objects. Error from a change of temperature is almost entirely eliminated by a proper proportioning of plates and solution, the resistances of which change in opposite directions.

Safety Arrangements.

Much has been said about the dangers of fire from the introduction of electricity, but if the wires are properly laid, and means be taken to cut out a circuit when for any reason a short circuit takes place, causing, of course, an instant increase of current, there is no reason for apprehension. All wires, besides being insulated, should either be run through the brick or stone of a structure, or run along the walls, and should be covered by a moulding to prevent accidental joining of the two wires. Mr. Edison has adopted this plan. The switches have large bearing surfaces, and the contacts are broken sharply to prevent arcing. But, aside from these arrangements, he has introduced a feature which is an absolute necessity, which is now recognised essential to any and all systems of distribution for domestic purposes. This is a weak point in every main, derived, and sub-derived circuit. This weak point is a bit of wire of lead and tin alloy, which is mounted in a plug, and can be readily replaced when destroyed. In the event of a short circuit, the sudden increase of current fuses this wire before it can possibly heat the copper conductors. The wide-spread application of these safety plugs and their reliability, is, I think, one of the most admirable features in this system.

With the exception of the main conductors, which are enclosed in iron pipes and insulated by composition, I have considered the principal points of Mr. Edison's system in detail. Let us look at it as a whole. I will first run hastily over the plant at the late Crystal Palace Exhibition, a piece of such thoroughly satisfactory character that we may consider it with profit. There were about 1,075 mixed lamps distributed in the entertainment court, concert room, domestic exhibit, booths, and railway entrance, all supplied by the same main conductors, and arranged in branch circuits with switches and safety plugs. These 1,075 lamps were the equivalent of about 840 standard lamps, and the current was supplied by twelve dynamos. In designing the plant, one object in view was to get an independence of power, such that the failure of any part would not cause extinction of the lamps. The motive power consisted of three Robey, non-condensing, double-cylinder engines, which are well enough known to all of you. Each fly wheel gave motion to a loose pulley, which, through the medium of a movable cone pulley, drove a section of shafting to which were belted the dynamos. In this way the breaking of an engine would stop four machines only, two could be stopped by shifting the cone pulley, and one, of course, by throwing off its belt. Aside from reliability, this arrangement steadied the current, and minimised the effect due to any irregularity of an engine. With seventy standard lamps as the full work of a dynamo, one machine should be added for every seventy lamps added to the circuit, so that the relation of internal and external resistances should remain the same. The twelve machines being in parallel circuit, the internal resistance of the system was about ·017 ohm. The twelve pairs of field coils were also in parallel circuit, making their resistance 3·46 ohms, and the external resistance, not including the main conductors, was about ·17 ohm, the ratios remaining the same as exists in a single generator worked to its full capacity. The engines ran at 120 revolutions, driving the dynamos from 1,100 to 1,200. They did their work steadily, developing about 40 to 45 indicated horse-power. The machines ran very quietly, and with very little sparking. In the field circuit was placed the regulator, which consists of a series of open wire coils, joined to segments of a circle, around which travels an arm, which, by successive contact, throws into circuit one or more coils, thus increasing the resistance of the field circuit, and changing the ratio of the resistance of this circuit to that of the lamp circuit without very materially changing the total resistance. By the movement of the lever, the lights could thus be regulated in intensity. The eye is a very poor judge, and to indicate an abnormal potential a magnet was bridged across the mains, just as the lamp is done, and the tension of the armature spring regulated so that when the potential increased, the increase of current caused the armature to move and a bell to ring. Such an arrangement, however, shows only the fact that the current is too strong, that is, the potential too high, and in a large system a much more delicate arrangement is used, the deflection of a spot of light on a graduated arc of large radius. The manual labour now used could be easily dispensed with, for the current in the galvanometer circuit could control a delicately adjusted armature, which, being moved one way or the other, would throw into action mechanism to operate the lever, or could close or reverse the current of a small motor to do the same. The use of the regulator should be as limited as possible, because a resistance which has no other function than diminishing a current is not to be commended; therefore, but very few coils should be in circuit for any length of time, and the regulator should find its office principally in meeting any sudden changes in the external resistance. With a resistance of one-fourth of the field magnets 12 70-light machines would absorb for regulation less than one third of a horse-power electrically—that is, about the energy used in four lamps. This is so small an amount that, considering the object that is attained, it cannot be objected to. In a large system the change of E.M.F. will be much smaller than would be necessary in a small one for the same numerical change, and any marked changes will be met by suitable changes in the number and speed of the generators; and it is just when machines are added or taken away that the regulator will be most in demand.

Whether the shunt system or the method of separate exciting for the field magnets will be found preferable will, probably, only be ascertained after a considerable experience. When there are but few machines in action I think, unquestionably, the shunt system, with comparatively high resistance of the field coils, is by far the best. These questions will be settled by trial, no doubt, when a large system is in working order, and are matters of relative economy and practice, not at all of the successful distribution of electricity, which is an assured fact. Just as small machines may be coupled in parallel circuit, so may large ones with satisfactory results. This coupling of machines of low resistance in parallel circuit is absolutely necessary, and the only way possible for a system of distribution to lamps direct from the machine. When so joined the loss of energy in the armatures bears precisely the same ratio to the total energy expended as exists in a single generator.

Were the lights at the Crystal Palace furnished by one machine having an armature resistance equal to that of one of the armatures of the small machines, there would be a loss of over ninety-two horse-power, enough to drive nine machines. When the machines are joined there is the same immunity from harm in case of contact as in a single machine.

At Holborn-viaduct there are, as many of you know, about 1,100 to 1,150 lamps furnished from the central station, distributed over a space extending from Holborn-circus to the Post Office. The system of distribution here is that of mutiple arc and branch circuits. Evidently, while simple circuits give perfectly satisfactory results in buildings, and on the street for short distances, they will not do for large districts. And it is this question of distribution over large areas to which Mr. Edison has given a great deal of thought, and has, I think, satisfactorily solved the problem.

Imagine two great sheets of copper in juxtaposition maintained at a certain difference of potential. If in either of these plates there exists a difference of potential at any two points, there will be a general flow of electricity set up to restore the plate to a state of equilibrium, just as occurs in the earth's surface, and this flow will continue as long as any inequality of condition exists. If these plates be joined by conductors, currents will flow proportional to the difference of potentials and the resistance of the conductor, just as if these plates were the terminals of a machine. Let such plates be the terminals of a machine, or better still, of several machines, and let the actual connections be made at several different points. There would now be a system of distribution, as far as regards the conductors, on the most perfect principles, and if the resistance of the connecting paths is less, that is, the number of paths greater at one point than at another, then there would be at that point, on account of the greater demand for current, a greater tendency to reduce its potential, and currents would flow to it from the surrounding parts. Such plates are evidently impossible; but perforate these plates, or, in other words, replace them by networks or meshes of cables, and we have a perfectly practicable method of providing a distribution, and I think the most satisfactory one. The way of laying down a district on this system is to lay the main cables in each street, and wherever they cross

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join like to like. This is to be supplied by mains from the central station at several different points, which points are determined by the relation of the size of the conductors, and the resistance of and allowed variation in intensity of the lamps. A peculiar thing, at first sight, is that the direction of the current in the street conductors will not always be the same, but will change so that the maximum flow is towards the point where there is the greatest demand. The relative sizes of conductors are calculated for the maximum currents they are to carry, and in order that the percentage of loss may be the same a double current would require a conductor of double cross section. The main conductors diminish in size as the distance from the several sources of supply increases, and the several districts in the city, each being primarily fed by a single system of generators, are joined together. If one half of these conductors were broken, the remainder could still supply the district. Small wires from every part of the city can be taken to one central office, so that the actual state of the potential may be known at any instant at any point, and even an automatic graphic record kept. In this way, one man can keep constant supervision of the whole system, having thus a check on the local engineers, and, by telephonic communication, give the necessary directions to increase or lower the potential or supply. In every dynamo room, a dial can be placed in a shunt from the cable of each machine, which will indicate the number of lamps, or the amount of current which the machine is supplying.

I have made no mention whatsoever of the application to power, which I will consider at another date, nor have I spoken of storage batteries in connection with this system, and I think with Mr. Edison that they are not a necessary adjunct. The variation of light would be remarkably small, and the failure, as far as the street mains is concerned, is practically impossible. There then remains the question, what is the liability of breakdown at a central station? If there is but one central station, the only way in which it could be disabled would be the blowing up of the major part of its boilers, and this is not very probable; in fact, I do not see how it is possible for such thing to occur with good boilers properly arranged. The breakdown of a single engine, the failure of one or two armatures, is quite possible, and we may say, probable. But such breakage would not seriously affect the supply, for aside from the fact that there would probably be a reserve dynamo, the machines can be easily run to over their normal power. In a city the entire destruction of a central station would not put out the lights in its own district, for the mains would be supplied from those of the surrounding districts. The calculation of the size and number of the supply and distributing mains is a work of careful engineering. It involves the cost of iron and copper, of coal and property, of labour, of capital invested and interest required—in short, how much of the energy of the current, of the coal, can be wasted, and in what part of the system. So each city must be the subject of special calculation, but it is perfectly practicable.

Such is a brief *résumé* of Mr. Edison's system as it has appeared to me after long and thorough study, a system in the fullest sense of the word, one of supply, measurement, and consumption, elaborate in detail, broad in conception. When we consider the present uses of electricity, and the uses which will be developed when it is at every householder's command, we will be more able to appreciate the importance of Mr. Edison's work, and although there is improvement to be looked for, I think he can feel satisfied that he has practically accomplished the work he set himself to do.

THE DEVON AND CORNWALL ELECTRIC LIGHT AND POWER COMPANY.

The first ordinary general meeting of this Company was held on Wednesday, at the Cannon-street Hotel, Mr. W. H. Owen in the chair.

Mr. F. B. Lidstone (the secretary) having read the notice convening the meeting,

The Chairman said that this was what might be termed their statutory meeting. It was the meeting which was usually held according to the statute regulating joint stock companies' proceedings, which provided that the first general meeting should be held within four months of the time of registration of a company. Usually there was nothing to say at such meetings further than to give such information as the shareholders might desire to have, and that he would proceed to give as shortly as possible. The first thing he might say was that he rather regretted to see so few of the shareholders present, but no doubt the directors might take it as a compliment, because if they had wanted to find fault they would have attended. The Company only having been formed a short time, not much business had been done. The nature of the goods they had to offer to the public was not such as to admit of their simply being shown and a purchase made. The introduction of the electric light was a process which must be gone through cautiously, carefully, and quietly, as there was a very strong interest in the gas companies opposing it. People expected to have the electric light on the same terms as gas, but he argued that they ought not to expect to have a superior article at the same price as an inferior. Still, there was a prospect of doing something, particularly at Plymouth, a very enterprising place. Plymouth had received offers of the light very cordially indeed, and the directors were in communication with persons for the purpose of installing the light there, provided they could come to terms. In the month of July there was a very extensive fancy fair held in the city of Exeter, and the light was shown there, the hall in which the proceedings took place having been most successfully lighted up, and the Company had received payment for the three days, and there was the payment for one day to be received. There was a prospect of doing further business in Plymouth, and there was a probability of their lighting the dockyard. One or two shareholders had expressed the opinion that the directors might have done more business. Business could be done to any extent, but the directors wished to make a profitable return, and were cautious not to go into matters which might not result profitably. They were carrying on negotiations for the introduction of their electric light at Penzance, the head-quarters of the mining interest of Cornwall. There was there a very large field for the introduction of the light into Cornish mines. Although the Cornish mines were not in any danger from gas explosions, yet the electric light would be of immense advantage to them. An exhibition of the light would be made at Penzance on the footing that Penzance should cover all the expenses, and he thought that that would be a very good advertisement to the Company. This being the statutory meeting, he had no resolution to propose.

Mr. J. S. Tyler said the Company issued a prospectus stating that the Company had the exclusive right to the Lane-Fox incandescent lamp, but he found on search that a general license had been granted to the British Electric Light Company for the use and sale of the lamp to Great Britain and Ireland. It seemed from the register that that license was granted in consequence of an agreement which Mr. Lane-Fox had previously entered into with the British Electric, and in consequence of proceedings which they took against him in the Court of Chancery. He searched the register carefully, and did not find that there had been any revocation of that license, and, even if the license were revoked, the non-registration of the revocation was a serious matter for this Company, seeing that if the British Electric Company liquidated, and Mr. Lane-Fox become bankrupt, the trustee of his bankruptcy or the official liquidator of the British Electric Light Company might have very important rights, to the detriment of this Company, in consequence of the non-registration of the revocation. He also asked whether any fresh contracts had been entered into since his interview with the directors yesterday.

The Chairman said the questions put by the last speaker resolved themselves into one, because it was the head and front of the thing. The question was, "Is it or is it not a fact that such and such a transfer was made?" whether, in fact, they had the exclusive and legal use of that which had been guaranteed to them. Unless the directors had supposed that they had such a right, they certainly would not have issued such a statement in their prospectus. If the facts were not as stated, certainly this Company had a remedy against the parent company, the Great Western Company, and the Great Western had its remedy against the Anglo-American Brush. If the vendors had sold what they had no right to sell, it was pretty clear there was a remedy.

Mr. Tyler did not consider the explanation satisfactory, and moved for a committee of shareholders to investigate the question.

The motion was not seconded, and, after some further discussion, a vote of thanks to the chairman terminated the proceedings.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Sept. 6.		Business Done Week Ending Sept. 6. Highest.	Lowest
Anglo-American	50¾,	51¼	51⅝	50¾
Do. Preferred	81,	82	81¾	80
Do. Deferred	20,	21	21¼	20
Brazil Submarine	11¾,	12	12	11¾
Cuba	9¾,	10¼	10 3-16	10 3-16
Do. Preference	16,	17	—	—
Direct Spanish	6,	6⅛	6 7-16	6 7-16
Do. Preference	15,	16	—	—
Direct United States Cable	11½,	12	11 11-16	11 11-16
Eastern Telegraph	10½,	10¾	10¾	10½
Do. 6 per Cent. Preference	12¾,	13¼	13 1-16	12¾
Do. 5 per Cent. Debentures, 1899	100,	105	—	—
Eastern Extension	11½,	11¾	11⅜	11 3-16
German Union	9¾,	10¼	10	10
Globe Telegraph and Trust Company	6½,	6¾	6 11-16	6⅜
Do. Preference	12½,	13	13	12¾
Great Northern	12¼,	12¾	12¾	12¾
Indo-European	29,	30	—	—
Mediterranean Extension	2,	2½	2¼	2¼
Do. Preference	8½,	9	9	9
Reuter's	12¾,	13¼	12¾	12¾
Submarine	255,	265	260½	258
West India and Panama	1¾,	2¼	2 1-16	1 15-16
Do. 1st Preference	8¾,	9¼	9½	8⅞
Western Brazilian	7,	7½	7	7
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1¼,	1½	1⅜	1 5-16
Oriental	⅝,	⅞	¾	11-16
United Telephone	10¼,	10¾	11¼	9⅝

ELECTRIC LIGHT.

Maxim-Weston	⅜,	⅝	9-16	½
Anglo-American Brush	10¾,	11¼	12½	10¾
Eastern Electric	2½ (£4 paid)		2¾ (£4 pd)	2½

TRAFFIC RECEIPTS FOR AUGUST, 1882.

Companies.	June, 1882.	June, 1881.	Incrse.	Decres
Cuba Submarine Company	2,550	2,401	49	—
Direct Spanish Telegraph Company	1,790	1,507	283	—
Eastern Extension Telegraph Company	32,025	30,349	1,676	—
Eastern Telegraph Company	51,600	38,171	13,429	—
Great Northern Telegraph Company	23,360	—	—	—

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

380. Improvements in Automatic Electro-magnetic Piano and Organ Players, *C. N. Andrews, San Francisco. 25th January, 1882. 6d.*

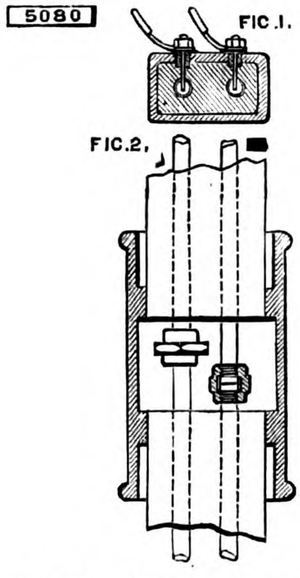
This consists in an improvement on the method of playing organs, &c., by means of a strip of paper, with slots corresponding to the length of note required, &c., revolving on a cylinder in connection with positive pole of a battery, and a rod in connection with the negative pole, so that when the paper is moved and the rod makes contact with the cylinder through a slot, a note is played. The keys or valves of the instrument are operated by an automatic circuit closing and breaking apparatus, consisting of an electro-magnet and armature mounted on a lever arm connected to the key or valve to be operated. This apparatus is illustrated in the specification.

616. Purifying Middlings, *W. R. Lake, London.—8th February, 1882.—(A communication from The Electric Purifier Company, Incorporated, New Haven, U.S.).—Complete. 6d.*

This relates to improvements on patent No. 727. A.D. 1880, in which rolls are caused to present an electrified surface to the material to be operated upon, and which is kept agitated, so that the lighter particles are attracted by the rolls which convey them away; and the first part consists in the use of reciprocating plates in place of such revolving rolls; the second part of the invention relates to the use of stationary electrified plates instead of a moving belt, the receiver carrying the material to be treated being caused to reciprocate beneath such plates.

5080. Improvements in Apparatus for the Conduction and Distribution of Electric Currents, *R. E. B. Crompton, London.—21st November, 1881. 6d.*

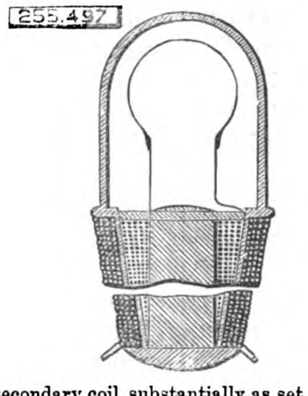
The inventor enlarges the end of two copper conductors, and on these ends cuts screw threads,



the pitch of the thread on the end of each conductor having a slightly different pitch; over these ends is fitted a sleeve or socket, and when this is screwed up the conductors are forced into intimate contact, Fig. 1. The conductors are placed in pairs in iron tubes and retained in proper position by core nails; the tubes are then placed in a vertical position, and purified blast furnace slag poured in to insulate the conductors. To procure intimate contact between the conductors and slag the former are enamelled. The core nails are then withdrawn and the holes made by them filled with insulating material. For a branch circuit, a copper plug is screwed into the conductor and brought out through a porcelain washer, the branch wire being connected to the stud as in Fig. 2.

255,497. Incandescent Electric Lamp, *Philip H. Diel, Elizabeth, N.J.—Filed January 10, 1882.*

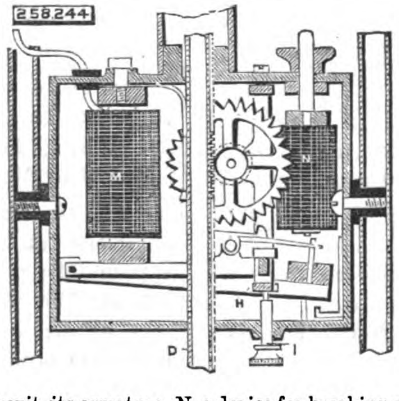
Claim.—(1) An electric lamp consisting of a hermetically closed glass globe, a light-giving part inside the globe, a secondary coil supported within the globe and placed in circuit with the light-giving part, and a primary coil arranged exterior to said globe and in inductive relation to



the secondary coil, substantially as set forth. (2) The combination of a glass globe containing the light-giving part, an extension made integral therewith, and a secondary coil supported at the interior of the extension and placed in circuit with the light-giving part, and of a primary coil arranged exterior to the globe and in inductive relation to the secondary coil, substantially as specified.

258,244. Electric Arc Lamp, *Richard R. Moffat, Brooklyn, N.Y.—Filed December 13, 1831.*

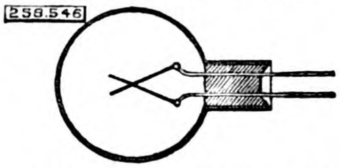
Claim.—(1) In an electric lamp, the combination of the electro-magnet N, forming part of a derived circuit, its armature, N, a device for breaking and closing said circuit, the moving frame H, escapement G, escapement wheel E^1, pinion E, racked carbon-holder A, and means for allowing the armature to move a sufficient distance to insure the working of the escapement and the operation of the feed mechanism before breaking the circuit, and which also permit said armature to return to or near its normal position before closing said circuit, substantially as specified. (2) In an electric lamp, the combination of an electro-magnet, N, forming part of a derived



circuit, its armature, N, a device for breaking and closing said circuit by said magnet, mechanism for feeding the carbons, and means for moving and adjusting the magnet N for the purpose of increasing or diminishing the space between said magnet and its armature, substantially as specified. (3) In an electric lamp, the combination, with the carbon-holder D, of the moving frame H, guide rods C C, wheel E^1, escapement G, armature frame V, and the electro-magnet M, substantially as and for the purpose specified. (4). In an electric lamp, the combination of the carbon-holder D, the moving frame H, wheel E^1, guide rods C C, armature frame V, electro-magnet M, and the adjusting screw I, substantially as and for the purpose specified.

258,546. Electric Incandescent Lamp, *Emile Berliner, Boston, Mass.—Filed March 31, 1882.*

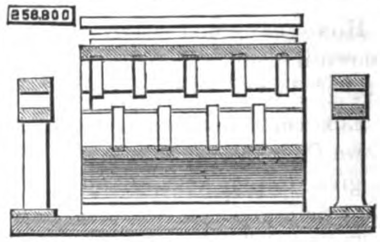
Claim.—(1) An electric lamp, consisting of two electric barbons in loose contact with one another, and enclosed in a transparent or semi-trausparent vacuous chamber. (2) An electric lamp, consisting of two conductors, overlapping and in loose contact with one another, and enclosed in a vacuum. (3) In an electric lamp, a vacuous



chamber containing a conductor consisting of an elastic carbon, as described, and in loose contact with another conductor, substantially as described.

258,800. Dynamo-Electric Machine, *William S. Parker. New York, U.S.—Filed March 4, 1882.*

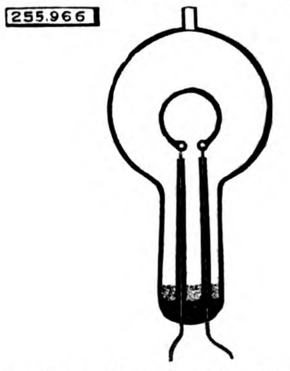
Brief.—The pole pieces of the field magnets are of cast iron, and have grooves in their faces next the armature. The grooves are filled with soft



iron bars. The carriers for the armature coils are formed of thin iron turned up at the edges, and having slots cut through the turned-up edges.

258,966. Incandescent Lamp, *Edward Weston, Newark, N.J., assignor to the United States Electric Lighting Company, New York, N.Y.—Filed 12th July, 1881.*

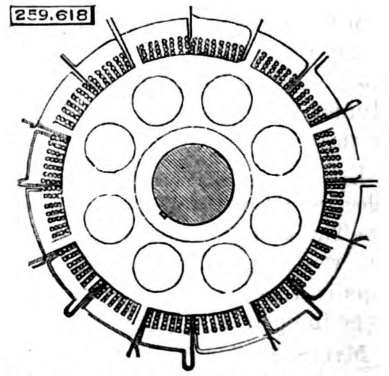
Claim.—An electric lamp, consisting of a transparent, exhausted, and hermetically-sealed receiver surrounding a conductor capable of being



rendered incandescent, and containing a small quantity of an air-absorbent substance, such as thorina, as and for the purpose set forth.

259,618. Dynamo-electric Machines, *Edward Weston, Newark, N.J., assignor to the United States Electric Lighting Company, New York, N.Y.—Filed December 13, 1881.*

Brief.—The armature is wound with two systems of coils, each section containing four coils, those of each system being alternately above and



below. The terminals of the two systems are connected to form a continuous circuit in the armature.

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SLIP

JAMAICA.—The cable between Jamaica and Colon is interrupted.

THE WAR.—Colonel Webber, R.E., has taken control of the telegraph at Ismailia.

PERSONAL.—Mr. J. Keatinge Pollock has been appointed general manager of the Metropolitan (Brush) Electric Light and Power Company.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 8th inst. amounted to £3,247.

ELECTRIC LIGHT IN BATH.—Messrs. Evans and Owen, of Bath, are having the newly built portion of their premises fitted with the Gülcher arc lamp.

HONOURS.—M. Denayrouse, an engineer of Paris, not unknown in connection with electrical industries, has had the title of Chevalier of the Legion of Honour conferred on him.

ELECTRIC LIGHT FOR SCARBOROUGH.—The Scarborough Town Council have decided that "it is undesirable at present to give consent to any application for a license under the Electric Lighting Act."

EDISON v. MAXIM.—A suit has been brought by the Edison Company against H. E. Maxim for infringing Edison's incandescent lamp patents. The trial will probably take place in Paris in November next.

EDISON'S LAMPS.—The Edison Electric Light Company, of 74, Coleman-street, E.C., announce that the price of their lamps is now reduced to 4s. each for quantities of 100 and upwards, and 4s. 6d. each for smaller quantities.

SS. CALABRIA.—This cable ship, belonging to the Telegraph Construction Company, which is now engaged as a transport, was to arrive at Portsmouth on the 20th inst. from Alexandria. She is then to embark 200 horses for Egypt.

ELECTRIC LIGHTING IN PARIS.—The Gare de l'Ouest at Paris has been lighted by means of the Edison system. The same system has also been introduced into Besançon, the motive power being furnished by a waterfall about a mile distant.

DIRECTORSHIP OF RUSSIAN TELEGRAPHS.—It is announced from St. Petersburg that General Besak, Governor of Nishni-Novgorod, has been appointed Director of Telegraphs in the place of General Lüders, whose death we alluded to in our last issue.

THE EDISON LIGHT IN PARIS.—Sixty Edison lamps have been in use at the Prefecture of the Seine, Paris, for several months past, and have given great satisfaction. The necessary plant was imported into France by special permission of the French Minister of Commerce.

MUNICH ELECTRICAL EXHIBITION.—This exhibition opens to-day (Saturday), and there is promise that it will prove interesting. Our special correspondent has already left for Munich, and we shall hope to be able to give some particulars of the exhibits, &c., in an early number.

ELECTRIC LIGHT IN THEATRES.—The Maxim-Weston Electric Company are now lighting the Court and Alexandra Theatres at Liverpool by their system of electric lighting. The work of lighting two other theatres in that town is rapidly approaching completion, and the lights are expected to be in operation shortly.

MILITARY TELEGRAPHISTS IN AMERICA.—It is stated that the surviving members of the American military telegraph service have decided to organise a "Society of the United States Military Telegraph Corps." Mr. W. R. Plum has been elected the first president, and a meeting is to be held at Niagara Falls on the 21st inst.

A NEW DEPARTURE.—The title "Telegraph," Daily or otherwise, which has had such a charm for newspaper projectors hitherto, must now yield to the later favourite, "The Telephone." We have heard of more than one newspaper started lately under the title *The Telephone*, the latest addition to the list being from Ballarat, Victoria.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The gross earnings of this company's traffic and steamer for the month ending July 31, 1882, amounted to £3,475 against £3,120 in the corresponding period of last year. For the month ending August 31, 1882, they amounted to £3,400 against £3,185 in the corresponding period of last year.

A MONASTERY STRUCK BY LIGHTNING.—The Franciscan Monastery of Castagnovissa, near Goerz, in Austria, was struck by lightning a few days since. A great fire resulted, which was only subdued by strenuous exertions. In the Monastery are the graves of Charles X., Louis XVI.'s daughter, the Duke of Angoulême, and the Duchesses of Parma and Berry.

PROPOSED NEW CABLE TO AFRICA.—According to recent news from Cape Town a deputation appointed by the Chamber of Commerce had waited on the Premier to request the co-operation of the Government in the establishment of a western line of cable communication with Europe. Mr. Scanlen, however, held out no hope of the line being subsidised by the Government.

THE VAN RYSSELBERGH TELEPHONE AND TELEGRAPH SYSTEM.—A correspondent writes that the statement made by Mr. Preece in his paper read before the British Association, to the effect that the remarkable telephonic results produced by this system had the effect of "retarding the telegraphic currents," would appear to be a mistake, as telegraphy is actually facilitated.

ELECTRIC LIGHT AT GRIMSBY.—During a *fête* held in the grounds of Mr. J. Wintringham, at Grimsby, in aid of the funds of the Hull and Grimsby Orphan Home, the grounds were lighted by Brush lamps, supplied and erected by the Midland Brush Electric Light Company. There were six lamps altogether, the power being derived from an engine supplied by Messrs. Riggall and Hewins.

NEW DYNAMO.—A provincial contemporary reports the exhibition at Scarborough by a Mr. Herbert Grantham, a seaman, of a new dynamo constructed on the shunt principle. The machine was shown at work in the Aerated Water Factory of Mr. Jos. Peacock at Scarborough, and is stated to have kept both an arc lamp and several Swan incandescent lamps burning steadily. The same authority reports that Mr. Grantham will supply a small machine (no estimate of the size is afforded) for £30.

GLASGOW COLLEGE OF SCIENCE AND ARTS.—From the syllabus of classes to be held at this college during the forthcoming session, we ascertain that classes in magnetism and electricity, electrical engineering, telegraphy, electric lighting and transmission of power, as well as chemistry, will be held. In the first four subjects the classes will be under the guidance of Mr. A. Jamieson, the principal of the college, and well known in connection with electrical engineering. The classes commence on October 3.

TELEGRAPH STORES WANTED.—The Great Western Railway Company are inviting tenders for the supply of telegraph wire, instruments, and materials as required by them during

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the period from next November to October 31, 1883. Samples, &c., may be seen at the office of the storekeeper, Paddington Station, where also specifications and forms of tender may be obtained, as well as at Swindon Station. Tenders addressed to Mr. Fred. G. Saunders, secretary to the company, Paddington Station, will be received before October 2.

Society of Engineers.—A course of eight lectures is now being delivered at the hall of the Society of Engineers, 6, Westminster-chambers, Westminster, by Professor J. C. Fell, M.I.M.E., on Tuesday and Thursday evenings, 6:30 to 7:30, and will continue up to the 28th September, the subject being "Applied Electricity for Lighting and Motive Purposes." Tickets may be obtained from Mr. J. C. Fell, 23, Rood-lane, or at the hall of the Society of Engineers, 6, Westminster-chambers, S.W. The first lecture was delivered on the 5th inst.

Spanish Telegraphs.—The *Times*' correspondent, in a telegram from La Granja, Spain, dated 11th September, says:—"The Postal and Telegraphic Administration of Spain is a national disgrace. Letters are continually delayed or stolen, while telegrams are not only delayed, but repeatedly delivered in a condition quite unintelligible to the receivers. The entire Spanish press echo our complaints, but without result. The grievance is to be brought before the Cabinet, and it is to be hoped effective steps will be taken to remedy the evil, which has attained serious dimensions, especially in international correspondence."

New Company.—The South Staffordshire Electric Lighting Company has been formed with the object of supplying electricity for lighting, heating, and motive power, and also telegraphic, telephonic, and other means of communication. It has a capital of £100,000, in £5 shares. Amongst the first subscribers are Messrs. R. Williams, Wednesbury, ironmaster; J. Smith, Wednesbury, tube manufacturer; E. Horton, Darlaston, bolt and nut manufacturer; J. C. Tildesley, Willenhall, lock manufacturer; E. H. Carter, 33, Waterloo-street, Birmingham, accountant; E. Pritchard, C.E., Birmingham; and other local merchants, &c.

The Tynemouth Exhibition.—In addition to the Brush lamps which light the streets leading from the station to the Aquarium, where the above exhibition is held, and certain portions of the building itself, the Swan Company exhibit Swan incandescent lamps; the Maxim-Weston Company 90 Maxim lamps in the hall and annexe, and Weston dynamo and 10 Weston arc lamps in the Skating Rink. The Pilsen, Joel, and General Electric Light Company exhibit 10 Joel semi-incandescent lamps, 50 Gatehouse incandescent lamps, and six Pilsen arc lamps, also a six-light Schuckert dynamo. Messrs. Fowler, of Leeds, and Robey, of Lincoln, also show engines for driving electric light machinery.

Electric Lighting at Preston (Lancs.).—The streets of Preston, the People's Hall, and the large Dingle of the Pleasure Gardens, were illuminated by means of twenty-five Brush lamps on the occasion of the visit of the Duke of Cambridge to the Guild Festival last week. The effect of the light as seen from the top of the ravine, at the Pleasure Gardens, was splendid. This ravine is thickly wooded, and its natural beauty was much enhanced by the electric light. The whole of the work was carried out under the superintendence of Mr. G. Sharples, local agent for Messrs. Hammond and Co., who hold the concession of the Brush system for Lancashire, and gave great satisfaction.

The Electric Light as a Moth Catcher.—Dr. I. E. Nagle, of Vicksburg, Miss., suggests the use of uncovered electric lights for killing the moths *Aletia*, from whose eggs the destructive cotton worm is hatched. He believes that a few lamps properly placed would attract and destroy the moths, so as to protect a wide belt of cotton country. The plan would be well worth trying wherever electric lamps are in use In some parts of the South planters have found that brush fires or burning rubbish will attract the moths in swarms; and every female moth promptly killed prevents the birth of many worms. Whether electric lamps would prove more efficient or economical, only trial can determine.—*Scientific American.*

Atmospheric Electricity.—It was shown by Mensbrugghe, five years ago, that every liquid mass of which the surface is expanding or contracting becomes the seat of a thermo-electric current. If the variation of surface is produced near a bad conductor, such as glass or air, the current gives rise to the phenomena of static electricity. This hypothesis greatly facilitates the explanation of atmospheric electricity, provided that the spherules which constitute mist and clouds are constantly undergoing great variations of surface. Many of the luminous phenomena which accompany the shower of mercury, when forced through a porous cup by atmospheric pressure, or when shaken in a glass vessel in a darkened room, confirm these views.—*Bulletin de L'Academie Belge.*

Electric Light at Birmingham.—On Saturday evening last Messrs. Winfield and Co. invited a large number of persons to view the arrangements for lighting the Town Hall, as carried out during the recent musical festival. Mr. H. Lea, the engineer in charge of the work, explained the various apparatus from the dynamo to the switches and lamps, and illustrated in a variety of ways the complete control which the men in the machine room exercised over the lights. Signals being sent there from the hall, and the lights being instantly turned half-down, or wholly out at will, comparison between the light given by a single arc lamp of 10,000 estimated candle-power and the Swan lamps as a means of lighting the room were afforded, the result being greatly in favour of the Swan lamps, although their united candle-power was only about 6,000 or 7,000 candles, owing to the better distribution of the light.

Phosphor Bronze for Telegraph Wire.—The cost of a telegraph line depends far more upon the difficulty of laying than on the cost of the wire. In Brussels there are several instances where telephone wires are left unsupported for distances of 300 or 400 metres. These spans would be impossible with galvanised iron, or even steel wire, but are perfectly practical with phosphor bronze. The diameter usually employed is about 16 B.W.G., which affords a resistance of 38 to 44 tons per square inch. Phosphor bronze possesses this great advantage over copper, that it becomes very hard on being drawn into wire. With a slight reduction of sectional area in wire-drawing it becomes half-hard, and takes an elasticity which prevents all danger of elongation tension, while it can be easily rolled up and unrolled. The experiments made at the Berlin Industrial Academy have proved that phosphor bronze is capable of standing reiterated strains better than any other metal or alloy.—*The Engineer.*

American Science Association.—The thirty-first annual meeting of the American Association for the Advancement of Science was opened at Montreal, Canada, on the 23rd August, the same day that the British Association opened their Southampton meeting. Professor J. W. Dawson, F.R.S., this year's president, having been introduced to the meeting by the retiring president, Professor Brush, thanked

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the meeting for the honour they had done him, stating that their choice had no doubt been "determined by the wish to do honour to Canada," he being a Canadian, and also "to give to this meeting a character as thoroughly international as possible." He expressed the hope, therefore, that they would regard him not "as a Canadian, or an American, in the narrower sense of that term, but as the president of a society which, in meeting here (Montreal), assumes a continental and international character." Dr. T. Sterry Hunt, chairman of the local committee, then welcomed the association to Montreal, alluding to the difference there was in the size, prosperity, and scientific status of Montreal then and at the time when the association first visited it, some twenty-five years previously. Subsequent to Dr. Hunt's address, the work of the various sections was proceeded with. Amongst the papers read were several dealing with electrical subjects, abstracts of some of which will be found in our present issue.

Telephoning on Underground Cables.—Some interesting telephonic experiments were made on a subterranean telegraph cable lying between Cologne and Elberfelds, about 52 kilometers (= 32 miles) long a few days since. The experiments were made by Messrs. Felten and Guilleaume, telegraph cable manufacturers, of Mulheim on the Rhine, in order to show the possibility of using underground cables for telephonic transmission. Hitherto no effectual device has been found capable of overcoming the effects of induction, which have prevented speech through cables composed of several conductors, and therefore threatened to make the practical use of such cables for the purpose an impossibility. The trials, however, have plainly shown that by a special disposition of the cores the induction is done away with, so that not the faintest foreign sound is heard, no matter what is going on on the neighbouring cores. The cable was kindly placed at the disposal of Messrs. Felten and Guilleaume by the German postal authorities, and the trials were carried on in the presence of high telegraph officials, who pronounced themselves thoroughly satisfied with the success obtained. While telephoning was going on on one core (ordinary instruments being used for the purpose) the neighbouring cores were used for telegraphing by the Morse instruments, or for another telephonic conversation. Nevertheless, the voice of the speaker was clearly audible without being interfered by foreign sounds, as long as the circuits were arranged according to the method devised by Messrs. Felten and Guilleaume. The result of this trial is very important, considering the length of the cable used, and may be taken as indicative of a great future for telephoning by means of underground cables.

Association of Chambers of Commerce.—At the annual meeting of this association, which is to take place at Gloucester, on the 3rd and 4th of October, the following resolutions will be submitted for the consideration of the meeting by the delegates of the various Local Chambers of Commerce which have passed them. Under the head of "Foreign Telegraphic Communication" there are two resolutions on the programme, one passed by the Hull Chamber, which is as follows:—"That the Government be requested to enter into negotiations with foreign countries for the purpose of cheapening and facilitating telegraphic communication, especially with Russia and Sweden, and that this resolution be brought before the Government by the Associated Chambers." For the other the South of Scotland Chamber is responsible. It reads thus:—"That with reference to the resolution in favour of cheapening and facilitating telegraphic communication with foreign countries, adopted by this association last year at the meeting at Plymouth, and the reply of the Postmaster-General to the association's memorial thereon, the executive council be requested to take measures, in the interests of the commercial community, to have the views of the association properly represented at the next International Telegraphic Conference." There are two resolutions also in favour of an alteration of the present Patent Laws. The resolution of the Leeds Chamber is to the effect "That in the opinion of this association the present Law of Patents is very unsatisfactory, inasmuch as it greatly interferes with and discourages invention; and that the Executive Council urge her Majesty's Government to introduce a Bill for the amendment of the law, having for its principal objects the simplification of the formalities and reduction of the fees on obtaining letters patent," whilst that of the Birmingham Chamber runs as follows: "That it is highly desirable that the existing Patent Laws should be amended. That any amendment of them ought to contain provisions compelling patentees to manufacture within the United Kingdom all goods which are the subject of an English patent, or, at least, that they should be compelled to grant licenses to English subjects; that the cost of provisional protection should be reduced to a merely nominal sum in order to afford facilities to poor inventors; that the period allowed for provisional protection should be extended; that a memorial be presented to the Board of Trade accordingly." The Birmingham Chamber have also passed a resolution with reference to a standard wire gauge, the pith of which is: "That the Executive Council having approved of a standard wire and metal gauge based upon the scale of sizes recently suggested by the Board of Trade, steps be taken to urge upon that Board the desirability of legalising the use of the same."

The Edison Light in New York.—The following is a copy of a cablegram received by the Edison Company in Paris, announcing the lighting up of part of the New York district, and which, as it contains some information that has not been made known in the telegrams as yet published, we think may be of interest to our readers:—"Section central station lighted last night six miles street conductors, one hundred buildings each three to 100 lights, all directions around station and one kilometre distant, exact tests of conductors made, galvanometer showed loss of currents from leakage of six miles of conductors three hundred-fifty-one thousandth of one lamp, or less than one three thousandths of one horse-power. Ten to twenty buildings added daily, all consumers have light day and night without interruption, many consumers already ordered out gas meters, pay same price as for gas. Following extracts morning journals:—*Herald* says: 'In stores and business places there was strange glow last night; it was the incandescent lamps of Edison, last evening for the first time in practical lighting of first district. Lighting was eminently satisfactory, the luminous horse shoes did their work well.' *The Times* says:—'The giant dynamos were started at three o'clock, and they will go on for ever unless stopped by an earthquake. The light was more brilliant than gas, and hundred times steadier. Twenty-seven electric lamps in editorial rooms, twenty-five lamps in counting rooms made these departments bright as day, but without unpleasant glare. Was light that man could sit down under and write for hours without knowing he had any artificial light about him; was soft, mellow, and grateful to eye, seemed like writing by daylight, having light without flicker and without heat. Light was tested last night by men who have battered their eyes by years of night work, and who know

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good and bad points of light, decision unanimous in favour of Edison electric lamp against gas.' The *Sun* says: 'Drexel buildings, *Times* offices, Park, Bank, and *Herald* offices were among places lighted last night. Edison greatly pleased, said to our reporter, "I have accomplished all that I promised; it was not without some fear that I started the machinery this evening. I half expected that some new phenomena would interfere with working of light, but has been entirely successful. We have greater demand for light than we can supply, owing lack of experienced men to put in wires."' The *World* says: 'Most of the principal shops in Fulton-street and other places in the district were lighted last evening for first time, and will be continuously supplied from central station. Meters have been placed in buildings, and every building is inspected by board of fire underwriters before can be lighted. Lights are more brilliant than gas, and can be turned on or off at will; light is safest possible; you may wrap lamp in finest handkerchief, and break lamp with hammer, and handkerchief will not be scorched.'"

THE MAGNETO-SOUNDER.—This simple and ingenious device, says *La Nature*, has been devised by M. L. Wiessenbruch, a lieutenant in the Belgian Engineers, to serve as an outpost telegraph without battery. The object of these telegraphs being to establish communication between the main guards and sentinels, the distance they are required to operate over never exceeds two or three kilometres. Owing to the special character of these "flying" lines, a light, simple, portable, and at the same time powerful apparatus is necessary. The magneto telephone is not always powerful enough on account of the noise which arises during an action; the microphone is more powerful, but it is also more delicate, and requires regulation, as well as a battery, which often proves cumbrous. The magneto-sounder of M. L. Wiessenbruch resembles both the telephone and the Morse sounder. It is a magneto-electric transmitter weighing only 750 grammes. It can be enclosed in a box 13 centimetres long, 9 centimetres wide, and 5 centimetres deep, from which protrudes only the manipulating button, and the two terminals for attaching the conductors. The transmitter consists of a Gower magneto-electric telephone, with fine wire, the vibrating disc of which is made convex in its centre, so as to act as a spring under pressure. An ordinary Morse key is arranged upon this convex plate, and exerts pressure on its centre when the manipulating button is pressed. Each time that this button is pressed, the plate of the telephone, in virtue of its form, approaches the magnet sharply and develops an induced current in the coils. When the button is released, it takes up its former position as sharply, and develops a second induced current of opposite sign. A complete system of communication by this means includes a circuit consisting of a single wire connecting the two posts, and at each of these posts a magneto-sounder connected on the one side to line, and on the other to an ordinary Bell telephone, which acts as a receiver; the circuit is completed by the earth by means of a wire connected to the second terminal of the telephone receiver, and to the hilt of a sabre stuck into slightly damp ground. The operator works the instrument with his right hand and holds the telephone receiver to his ear with his left. The induced currents developed in the convex plate are far more energetic than the vocal transmission in the most perfect telephones, and the despatch can, therefore, be read by sound despite the surrounding noise. In experiments made by M. L. Wiessenbruch, he was able to insert a resistance equal to 600 kilometres of iron wire, four millimetres in diameter (6,000 ohms), without perceptibly interfering with the clearness of the reception. At the Exhibition of 1881, Colonel W. Jacobi, a Russian, exhibited under the name of *télékal*, a telephonic transmitter, without a battery; but it was much heavier, and more cumbersome than Lieutenant Wiessenbruch's magneto-sounder, since it weighed from five to seven kilogrammes, was 34 centimetres long, 22 wide, and 11 high.

ELECTRIC LIGHTING FOR LIBRARIES.—In a Note in our last issue we very briefly referred to a paper on this subject read before the recent meeting of the Librarians' Association at Cambridge, by Mr. Peter Cowell, librarian to the Free Public Library at Liverpool. We may now give a more detailed account of what Mr. Cowell said:—An excessive accumulation of heat in libraries, Mr. Cowell remarked, was inseparably connected with the case of books as well as the comfort and health of officials and readers. The money value of replacing bindings of books, the injury done to which was so greatly attributable to the effects of gas, was enormous. Ordinarily the reading room in connection with the Liverpool Library was lighted with electricity, but gas was provided as well in case of an emergency. The possession of these two rival modes of lighting had enabled him to ascertain their relative value in a library, and to bear his testimony without doubt or hesitation. The figures he had to give were of several thermometers, taken in the ordinary course of business, and entered in a book provided for that purpose. On December 21 last the room was lighted by gas. At four o'clock p.m. the thermometer stood at 58deg., at seven o'clock 66deg., at ten 69½deg. On a gallery eight feet above the reading room the temperature was uniformly half a degree higher. The next night the room was lighted by electricity. At four o'clock the thermometer registered 60½deg., at seven 62deg., and at ten 63deg. The gallery readings were at four 59deg., at seven 60deg., and at ten 61deg. Besides the effect on temperature, there were other advantages. One was the help it afforded to the pursuit of sketching or illuminating in colours copies of illustrations from books. This would be impossible with gas, and thus debar many from following a very agreeable employment who would have no opportunity in the hours of daylight. One or two recent calamities to public libraries by fire had brought home to them the jeopardy they stood in on account of the combustible nature of gas. Another advantage was its cleanliness. The effect of gas upon walls and ceilings caused a great expense, especially where scaffolding had to be erected. Though they are open to a late hour, up to the time of closing they experienced a freedom from that feeling of weariness and lassitude which they experienced when working in other parts by the aid of gas. Their light, he might say, had now outlived many of the dreadful things laid to its charge, and many of the frequenters of the reading room who were at first its greatest enemies were now its staunchest supporters. He had purposely avoided any approach to the scientific aspect of electric lighting, because it was wise that people should not meddle with what they did not understand. He did not contend that they have in the library at Liverpool the best lamp attainable, but this he would say, that it had never deceived them, nor left them in darkness. Touching the financial part, he could not speak quite so favourably, but taking into consideration the damage done to stock by gas, the margin against electricity was small. Perhaps as a popular library, open to a much later hour than most public libraries, the result of its use at Liverpool would be more generally accepted, and therefore he had ventured to trespass upon the time of the association with the foregoing remarks.

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MEASURING INSTRUMENTS USED IN ELECTRIC LIGHTING AND TRANSMISSION OF POWER.*

BY PROFESSORS W. E. AYRTON, F.R.S., AND JOHN PERRY, M.E.

(CONTINUED FROM PAGE 375.)

6. *Bifilar Suspension Electric-power Meter.*

In the paper read by us last spring at the Society of Arts, we described an electric-power meter which we had arranged for measuring by one observation the horse-power electrically

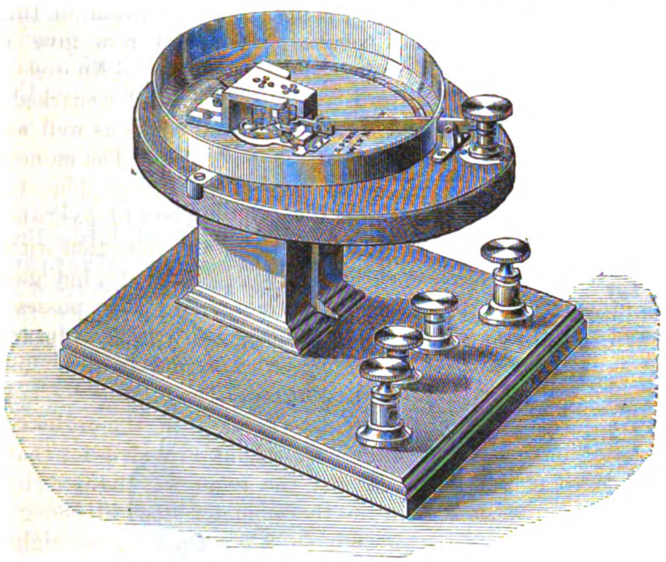

FIG. 5.—Wheel and Pinion Electric Power Meter.

given to any part of the circuit, and which, by the employment of our commutator principle, could be calibrated by employing very much smaller powers than the instrument was intended to usually measure. At the York meeting of the British Association, we exhibited the instrument which we had been employing for this purpose, consisting of a coil of very fine wire wound on a long thin bobbin, so that the coil had a very small moment of inertia, capable of moving about an axis parallel to the length of the bobbin. The coil was bifiarly suspended inside another fixed coil containing ten thick wires, each of exactly the same resistance, and which, by means of the commutator, could all be joined up in series or in parallel.

The thick wire coil is placed in the main circuit, while the fine wire coil acts as shunt to that part of the circuit, P Q, the horse-power electrically given to which it is desired to measure. The current passing through this fine wire coil therefore measures V, the difference of potentials between P and Q, hence the deflection of the coil measures the product of the main current A and V, and consequently the horse-power being electrically given to P Q. By turning the commutator to series, the sensibility of the instrument can be increased exactly ten times, either for the purpose of calibration, or when it is required to measure the power being given to, say, one incandescent light.

At the same meeting of the British Association, Sir William Thomson, before seeing our electric-power meter, described an instrument he proposed constructing on the same principle, and which he called an electro-ergometer. We have not employed this name because it appears to us to be not quite apt, since such an instrument measures the rate of doing work which is power, and not the *ergs* or amount of work done.

7. *Wheel and Pinion Electric-power Meter.*

This year we have modified our electric-power meter, employing the wheel and pinion and double spring already described in connection with the wheel and pinion ammeter and voltmeter, so that this instrument now takes the shape shown in the following figure. The outer and larger binding screws are for taking the wires which form part of the main circuit; the inner smaller binding screws for the finer shunt wires which are attached to that part of the circuit, the energy electrically expended in which it is desired to measure. One or both springs can be employed, and so two very different grades of sensibility are possible; also a definite amount of angular set can be given to either, so that a small change in a large horse-power will cause a great change in the deflection of the pointer.

8. *Transmission Dynamometer and Dynamometer Coupling.*

When describing our original ammeter to this Society, we described a form of transmission dynamometer we had devised for measuring the power given by an engine to a dynamo or to any other driven machine, and to this instrument we have recently added the same contrivance of a set-

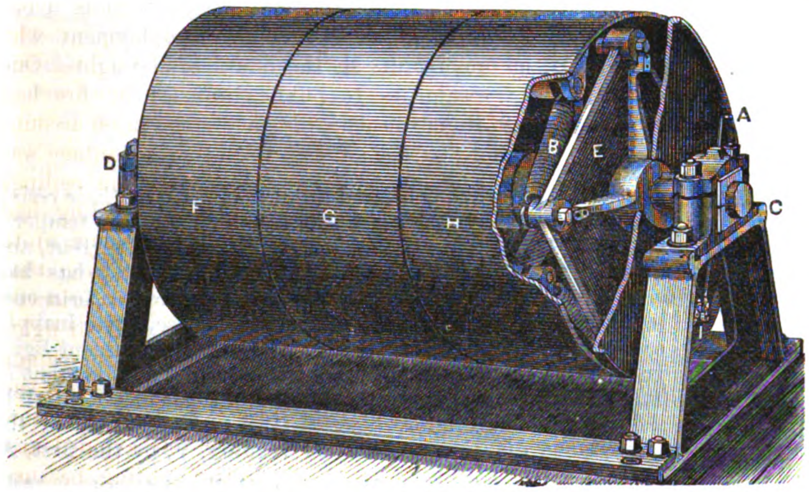

FIG. 6.—Transmission Dynamometer.

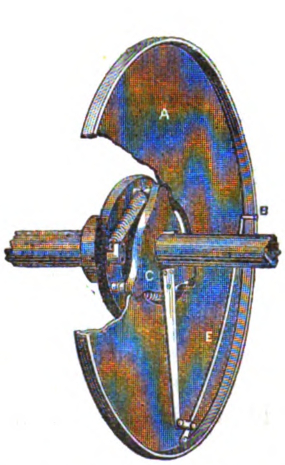

FIG. 7.—Dynamometer Coupling.

up spring used in the wheel and pinion ammeter and electric-power meter, to limit the whole range of the instrument to not very large changes on each side of the normal horse-power to be measured, and by this means to obtain with a limited scale great delicacy near the normal measured power. The instrument, as seen in the figure,† consists of a pulley, F, rigidly fixed to the shaft C D, a loose pulley, G, and a

* A Paper read before the Society of Telegraph Engineers and of Electricians.

† This and the following figure are from blocks used in Professor Perry's book on "Practical Mechanics," about to be issued by Messrs. Cassell, Petter, and Galpin, who have kindly granted us the use in advance of these two illustrations.

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pulley, H, joined by the spiral springs B, to the ribbed plate E, which is rigidly fixed to the shaft C D. If, then, the engine belt is on F, and the belt to the dynamo or driven machine on H, or *vice versâ*, the springs B will be stretched, depending on the "torque" or twist transmitted. The extension of these springs causes, by means of a small link-motion seen at the lower right hand curve of the figure, the bright bead A at the end of a long arm to approach the centre. Hence the smaller the radius of the circle described by this bright bead as it revolves, the greater the torque. Consequently, the horse-power transmitted is at once obtained from observing the indicated torque and the speed of rotation. The arm carrying the bead is slightly flexible, and when no power is being transmitted the bead is pressed with a certain force against the rim of the front plate, hence the bead does not commence moving until a certain pre-arranged horse-power at a given speed is being transmitted; its whole radial motion, therefore, is completed for a certain additional transmitted horse-power, the necessary addition depending on the power of the springs and the leverage of the link-motion. Consequently, a large change in the radius of the circle of light is produced by a small change in the transmitted horse-power. Further, one of the pins in the links can be taken out and put into another hole, which has the effect of greatly altering the leverage of the links, thus increasing the magnification and causing the motion of the bead to be completed for another range of power. For example, the springs and link motion may be so arranged that with one of the two adjustments the bead may commence to move when 8 horse-power is being transmitted at a certain speed; the whole motion from the circumference to the centre may be completed when the horse-power transmitted varies from 8 to 12. With the other adjustment, the bead may start moving when 4 horse-power is being transmitted, and the entire travel of the bead from the circumference to centre completed by this transmitted horse-power increasing from 4 to 6. Slipping either the driving or the driven belt on to the loose pulley G causes the transmission dynamometer and the dynamo machine to stop while the engine is going on.

The next figure shows our dynamometer coupling, which differs only from the preceding in that it is intended to be used with machinery driven directly by shafting where belting is not employed. For instance, this coupling may be used to measure the horse-power given by a fast-speed engine to a dynamo driven directly by it, or it may be employed to measure the power given by a marine engine to the screw or to the paddles, or generally the horse-power transmitted along any line of shafting; the spring coupling, in fact, replacing the ordinary coupling used with such shafts.

One of the halves of the coupling seen in the figure is keyed to the driving shaft—for example, the shaft of a fast-speed engine—and the other to the driven shaft—for example, that of the dynamo. The half C is attached to the other half by means of the spiral springs, and the stretching of these is therefore a measure of the torque. The angular motion of the one relatively to the other causes the bright bead B to approach the centre, and, as before, the radius of the circle of light measures the horse-power transmitted at any particular speed. The arm E, carrying the bead, is also, as before, slightly flexible, so that when no power is being transmitted the bead B is pressed with a certain force against the rim of the larger plate. Hence the bead does not commence to move until a certain pre-arranged horse-power, at a given speed, is being transmitted, and the whole motion is completed for any pre-arranged excess beyond this, thus enabling delicate measurements to be made at powers a little more or less than that normally transmitted.

By a proper arrangement of the link-motions, we have succeeded in making the radial motion of the bead in both instruments exactly proportional to the extension of the springs or twist transmitted.

The transmission dynamometer and dynamometer coupling just described have the great advantage over any sort of laboratory dynamometers in that the former have not to be put into position and adjusted for each particular experiment, but are always ready, and are always indicating the power transmitted at any given speed. If, for example, a dynamometer coupling be inserted in the shafting of a factory in place of the ordinary coupling, a glance at it at any time will show the power that is being transmitted by it. If two such dynamometer couplings be inserted at two places in the same set of shafting, the difference between the transmitted powers indicated by them is the power utilised by the machinery driven by that portion of the shafting that is between them. At present, masters of works, we think, have necessarily but rather a vague idea of the amount of power expended in different parts of their works—how much, for example, is used to drive one portion of the machinery and how much to drive some other. The substitution of a few dynamometer couplings, at well-chosen places, for the ordinary couplings, would settle this question.

9. *Ohmmeter.*

The next instrument, which, like all the preceding electric ones, is constructed by Messrs. Paterson, of 76, Little Britain, is for the purpose of measuring the resistance of any part of, say, an electric light circuit, while the strong current is flowing. At present the resistances of the field magnets, the bobbins of electric lamps, &c., are measured with the Wheat-

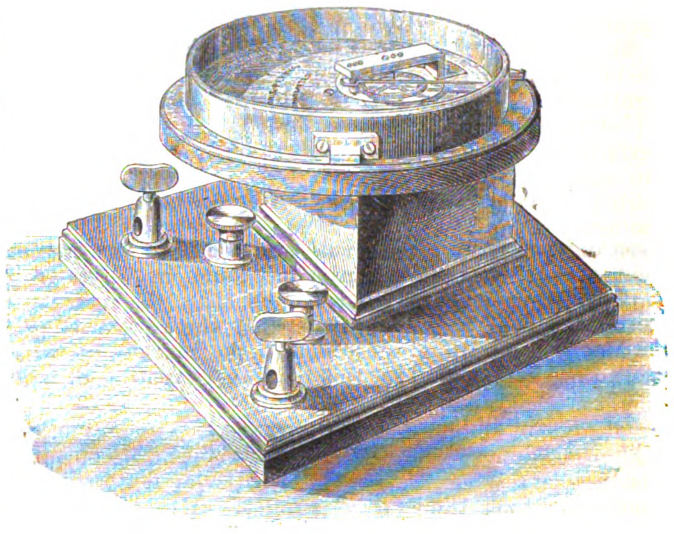

FIG. 8.—Ohm-meter.

stone's bridge when cold, and a guess is made at their resistance when hot by making a rough estimate of the temperature. A better plan than this is to stop the current, and quickly measure the resistance before the circuit has had time to cool; but even this method of measurement can only lead to approximate results, and is, of course, quite inapplicable to the resistance of either an arc or incandescent light. In such cases it is usual to measure the main current in amperes with an ammeter, and the difference of potential in volts with a voltmeter, between the two terminals of the lamp, since dividing the second reading, V, by the first, A, we have the ratio $\frac{V}{A}$ or R, the required resistance. And this method we have been in the habit of employing, not merely to measure the resistance of a lamp, but the resistance possessed by any part of the circuit while the current was flowing through it.

To avoid, however, always having to take two measurements, we devised some months ago an instrument which we have at length perfected for measuring the ratio at one reading, and this instrument, called an "ohmmeter," differs from the power meter in that, while the latter measures the product, V A, the ohmmeter measures the ratio, $\frac{V}{A}$.

This instrument consists of two coils, one of thick and the other of fine wire. Both coils are fixed, and with their axes

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at right angles to one another, and the currents flowing through each acts on the same needle. Through the thick coil the whole current A flows, and through the fine coil a shunt current which measuses V, the difference of potentials between the two ends of the part of the circuit the resistance of which it is required to measure; and the forces due to these two currents are at right angles to one another, hence the deflection of the needle may be made to measure $\frac{V}{A}$. By giving the proper mathematical shape to both the coils and to the needle, we have succeeded in obtaining the instrument seen in the accompanying figure, in which the deflections from zero are directly proportional to the values of $\frac{V}{A}$, that is, to the values of the resistances to be measured.

When the instrument is not in use, there is no directing force acting on the needle, and the pointer therefore remains anywhere. On allowing the main current to pass through the thick coil, by means of the outer and larger binding screws, the axis of the needle instantly places itself along the axis of the thick coil, and the pointer points to nought. If, now, wires be attached to each of the small binding screws belonging to the fine coil, and the other ends of these two wires be attached to the *same* point of the main circuit, the pointer still remains at naught, indicating that there is no resistance in the main circuit between the two points of attachment of the fine wires. If these wires be separated by, say, the field magnets of the dynamo, the pointer at once moves to a number indicating the resistance of the field magnets, &c. It will be seen, then, that the resistance of any part of the circuit can be measured at any time without interfering with the main current.

In actual practice, in fact, the ohmmeter is simply kept inserted in the main circuit anywhere, and when it is desired to measure the resistance of any part of the circuit, all that is necessary to be done is to connect, by means of two fine wires, the two ends of this part of the circuit to the two smaller binding screws of the ohmmeter.

By the employment of the wheel and pinion, a deflection of about 320deg. of the pointer is obtainable, and on the present instrument a deflection of 60deg. corresponds with 1 ohm, so that measurement of resistances up to 6 ohms correct to $\frac{1}{60}$ of an ohm can be accurately and quickly made. By altering the resistances of the two bobbins, the measured resistance corresponding with any particular deflection can be made anything we please.

One great use of the ohmmeter is that it enables us to dispense with resistance coils for experiments on dynamo machines. Any one who has used the resistance coils made for such purposes knows the difficulty of making coils of convenient size, whose resistances do not seriously alter with currents of 30 or 40 amperes. The coils cannot easily be made to cool fast enough to avoid the resistance seriously increasing with the current. We, on the other hand, use a bit of carbon, a bit of wet rope, or a pail of water, and measure with the ohmmeter the resistance of our extemporised resistance coil at the moment of making any experiment.

10. *Cylinder-spring Electrometer.*

For measuring differences of potential higher than 500 volts, the voltmeters already described are unsuitable, and recourse must be had to a portable modification of some form of Thomson's electrometer. We have devised two or three forms, one of which is seen on the table.

Two vertical pieces of metal, forming part of a cylindrical surface, are attached to a vertical arbor resting in jewelled bearings, and form the needle of the electrometer. This arbor is fixed to one end of an extremely fine spiral spring, the other end of which is fastened to the dial plate, which is itself electrically connected with one of the terminals A. This spring serves two purposes—the one to give the needle directive force, the other for keeping up electric connection with the needle which turns inside four concentric vertical pieces of brass, which together nearly form a complete cylinder of a radius slightly larger than that of the needle, and which replaces the quadrant in the ordinary electrometer. These are electrically connected alternately in pairs, as shown in the small figure; and one pair is also connected with the needle through the very fine cylindrical spring, symbolically represented as a spiral line in the small figure. If, now, A and B be maintained at a difference of potential, E, a deflection, D, will be produced, which it may easily be shown is proportional to the square of E. One great advantage of this well-known method of connecting up the needle and quadrants of a Thomson electrometer is that, although it does not produce as delicate an instrument as can be obtained by giving to the needle an independent charge, it enables the instrument to be used for measuring a rapidly-reversing electromotive force equally well as for measuring a non-reversing electromotive force; whereas a fine wire galvanometer or dynamometer cannot be satisfactorily used for measuring even a small rapidly-reversing electromotive force, on account of the retardation arising from self-induction.

The advantage of the special modification above described of the quadrant electrometer is that it is portable; and from the needle having but a small moment of inertia, while, at the same time, it is everywhere very near the fixed attracting surfaces, the instrument may be made partly dead-beat, and at the same time sufficiently delicate to measure the large electromotive forces for which it has been designed.

If it is desired to measure the horse-power electrically expended in any portion, P Q, of a circuit conveying an alternate current, a measurement of the strength of the current may be made with a suitable ammeter, and a simultaneous measurement of the difference of potentials between P and Q with an electrometer. The following arrangement of the electrometer, however, enables the mean product of the alternate current and alternate difference of potentials between P and Q to be measured with the one instrument:—

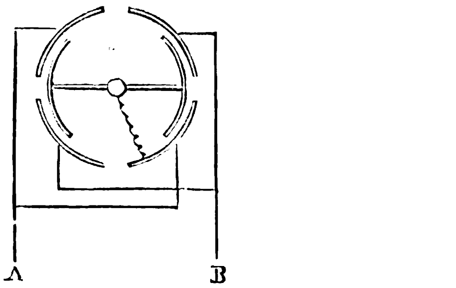

Fig. 9.—Cylinder-spring Electrometer.

Let it be desired to measure the energy electrically expended in a portion of the main circuit between two points, A and B, whose potentials are P and Q respectively. Connect these two points to the opposite fixed cylinders in the previous electrometer. Place in the main circuit, on either side of the portion A B (say, on the A side), a resistance, R, having no self-induction, and let its farther end, C, of which the potential is S, be connected with the movable cylinder of the electrometer; then the deflection D measures the mean value of $(P-Q)\left(S-\frac{P+Q}{2}\right)$. Now connect the needle with A, instead of with C; then the deflection D measures the mean value of $(P-Q)^2$. Hence $D - D'$ measures the mean value of $(P-Q)(S-P)$, which is obviously R times the mean value of the energy expended on the portion of the circuit A B.

A variation may be made in the second test, and which consists in connecting the needle with a point, D, in the resistance coil, such that the resistance between D and A is $\frac{R}{2}$; in that case D'' will measure the mean value of $(P-Q)\left(\frac{S+P}{2}-\frac{P+Q}{2}\right)$, in which case $D - D''$ measures the mean value of $\left(\frac{P-Q)\ (S-P}{2}\right)$, or $\frac{R}{2}$ times the mean value of the energy expended.

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12. *Dispersion Photometer.*

With this photometer measurements may be made in quite a small room of the illuminating power of the rays coming at any angle from even a powerful electric light. With the ordinary forms of photometer, the screen illuminated by the electric lamp must be placed so far away from the lamp that its brightness is the same as that of another screen, or of the other side of the same screen, illuminated by the standard candle. With the powerful electric lamps of the present day, a distance of 50 or 100 feet is necessary in order that a measurement may be made of the illuminating power by means of an ordinary photometer, and, in addition, it is very difficult to examine the light unless it comes from the lamp in a horizontal direction.

The principle of our dispersion photometer consists in the use of a concave lens to weaken the strength of the light (instead of placing the lamp far away from the screen), combined with the employment of a mirror turning round a horizontal axis, which makes an angle of 45deg. with its reflecting surface, in consequence of which rays coming at any angle from the lamp can be measured without the introduction of an error arising from the varying absorption at different angles of reflection; while, at the same time, a pointer attached to the mirror reads off on a graduated scale, G, attached to the instrument, the angle made with the horizontal by the beam of light under examination.

The instrument seen in the figures consists of a portable tripod stand, E, on which is screwed a small table, which is then carefully levelled. The photometer is next placed on this table, and the pin at F, directly under the centre of the mirror, is passed through the base of the photometer into the hole in the table. The photometer, by turning round this pin, can, without producing any change in the distance of the centre of the mirror from the lamp, and, therefore, without changing the distance from the screen to the lamp, receive the small horizontal motion necessary for the adjustment for a new inclination of the rays coming from the electric light. The divided circle G is clamped with the index at 0deg., the electric lamp is lowered or raised till the illuminated disc formed on the screen of blotting paper G by the reflected light passing afterwards through the lens is in the middle of the paper screen. A little sliding shutter, with a fine hole in its centre, seen in the figure, enables a very exact adjustment to be made; but in practice we find that we get sufficient accuracy without the use of the shutter. The instrument having been thus adjusted, the distance from the electric lamp to the centre of the mirror is next measured.

The candle in the holder D, sliding on the graduated rod J, having now been lighted, there will be seen cast on the screen of blotting paper B, two shadows, side by side, of the black rod A placed in front of it, one being cast by the standard candle, the other by the beam from the electric light after reflection at the plane silvered mirror H, and dispersed in passing through the concave lens in the sliding wooden frame C. The lens is now moved backwards and forwards until the intensities of these two shadows are equal when seen through the sheet of red glass supplied with the instrument, and again adjusted until the shadows are of the same intensity when seen through the sheet of green glass. *d*, the axial distance of the lens from the screen, as shown by the pointer attached to the lens frame on the fixed graduated scale, as well as *c*, the distance of the candle, also shown by the position of its pointer on its graduated scale, are now noted; whence if *f* is the focal length of the lens, and if D is the distance of the lamp from the paper screen (that is, the distance of the lamp from the mirror plus the fixed distance of the mirror from the screen), and if L is the strength of the examined source of light in standard candles,

$$\sqrt{L} = \frac{D-d}{c}\left\{1 + d\left(\frac{1}{f} + \frac{1}{D-d}\right)\right\},$$

or

$$L = \frac{1}{c^2}\left\{D + \frac{d(D-d)}{f}\right\}^2.$$

We prefer to employ the formula; but as all the common instruments which have hitherto been manufactured have lenses whose focal length is four inches, we have prepared a table, a copy of which is sent out along with each instrument, in which the value of L is given for various values of D, *d*, and *c*. Using this table, it is necessary to have the lamp at either 60, 120, or 300 inches from the screen; the candle is either at 10, 14·14, or 20 inches from the screen; and the table is made out for every half inch of the lens scale. But inasmuch as we find that the improved arrangement of the mirror already referred to constitutes perhaps the most useful part of the instrument, and as the use of this improvement involves many alterations of D, Mr. Sennett, of the Kirby-street Engineering Works, Hatton-garden, the manufacturer, proposes in future not to furnish any table of values of L unless specially asked for.

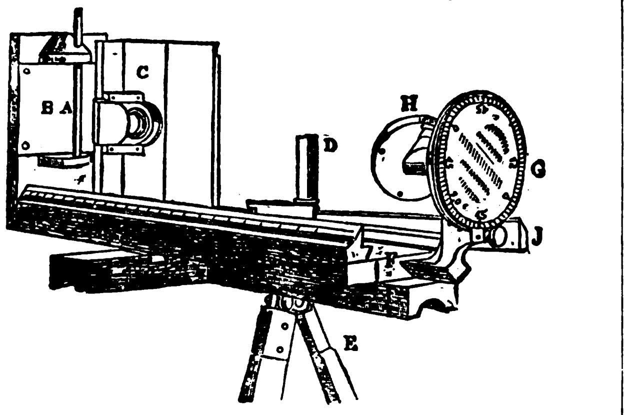

Fig. 10.—Dispersion Photometer.

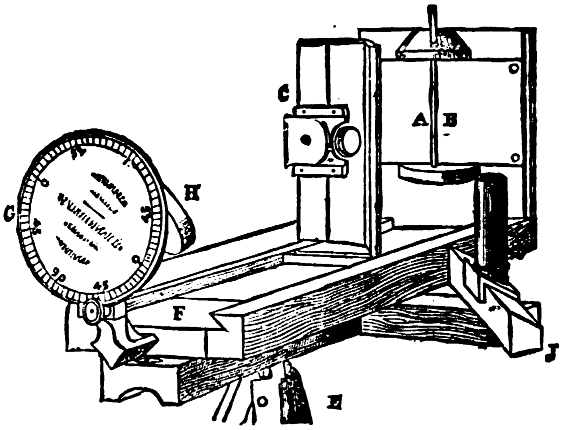

Fig. 10A.—Dispersion Photometer.

In these instruments we find that from 30 to 34 per cent. of the incident light at 45 deg. is absorbed, whether this light is of ruby red or signal-green colour, and practically none by the lens; so that we have the easy, rough, practical rule for all cases—add one half to the measured intensity of light reflected. For more accurate working the exact absorption of the mirror of the particular instrument employed is used.

The intensity of the horizontal beam having been measured, the electric lamp is now raised or lowered and fixed in any position; a few seconds suffice to turn the mirror so that it sends its centre ray exactly through the centre of the lens. The distance from screen to mirror in this instrument being 22 inches, if δ is the distance from centre of mirror to vertical from lamp, and if θ is the angle of elevation, then

$$D = 22 + \delta \sec\theta.$$

Using this value of D in the formula above, and adding one-half to the strength of the light to make up for absorption, or making the more accurate correction for the special instrument employed, the true intensity of the light in standard candles can be ascertained. In practice, if an electric light is moderately steady, ten measurements may be made, with

some confidence in their accuracy, in two minutes; and the light may be measured in ten different positions, from an angle of depression of 60deg. to an angle of elevation of 60deg., 100 observations being taken in less than half an hour.

We may mention one very important result we have been led to by the systematic employment of a photometer which can be used close to the electric light, and that is the large amount of absorption that occurs on certain days when the rays from strong electric lights, and especially the green rays, pass through the air, which appears to the eye perfectly clear. At first we were inclined to think the higher results for the candle-power of a lamp obtained with our dispersion photometer than those obtained with an ordinary distance photometer were due to some error in our photometer itself; but we have since ascertained that this is due to the absorption of the air, because we find that, if simultaneous measurements are made with ordinary Rumford's photometer's, each without lens or mirror, placed at different distances from the lamp in the same azimuth and in the same horizontal plane, the nearer one gives, as a rule, the highest readings, and the difference is the greater the stronger the light, and is greater if the light be examined at each photometer with green glass. The importance of such experiments in connection with the penetrating power of the electric light must be obvious.

13. *Electric-light Calculator.*

Having had occasion to make a large number of calculations of the illuminating power of various electric lamps, the horse-power electrically given to them, and the "efficiency" or number of candles per horse-power produced, we have devised, and had constructed a simple piece of apparatus by means of which all the necessary calculations can at once be made, and which, after being used to work out the results obtained from any one experiment, preserves, until it is again used, a record of all the numbers employed in the previous calculations—an arrangement which serves as a valuable check in preventing clerical errors. The apparatus consists of four concentric discs, graduated logarithmically, after the manner of the slide rule. The observed distance of the electric light from the photometer screen is sought for on Scale 1. Opposite this is brought the observed distance of the candle read off on Scale 2, and the pointer shows at once the candle-power of the lamp. On Scale 3 is read off the current in amperes passing through the lamp, and opposite this is brought the observed difference of potentials in volts between its terminals read off on Scale 4, when the second pointer shows at once the horse-power electrically given to the lamp. Finally, the illuminating power, as shown by the first pointer, is brought opposite the horse-power, as shown by the second, when the number of candles per horse-power is at once read off.

14. *Coulombmeter.*

We have also, mainly for the purpose of experimenting on charging and discharging Faure's accumulators, arranged an apparatus which registers the total quantity of electricity that has passed through it in any previous given time—an apparatus, in fact, which acts for electricity as a gas meter acts for gas. This coulombmeter is simply a small magneto-electromotor placed as a shunt to the main circuit, and acted on by *fluid friction*, which forms the essence of the apparatus, since such fluid friction opposes a resisting force directly proportional to the velocity, while, on the other hand, the force causing motion is proportional to the current; hence the current flowing is proportional to the velocity, and the total quantity of electricity that flows in any time is proportional to the total number of revolutions made by the motor in that time, and which are counted by an ordinary speed-counter attached to the revolving spindle. Hence the number of coulombs of electricity that have passed may be measured, by taking two readings of the counter, as easily as can the number of cubic feet of gas consumed by taking two readings of the gas meter.

This coulombmeter we have used for some time; but we have found this week that an instrument somewhat of this nature was patented some time back by Mr. Edison, although we are not aware that he ever used it, or whether he realises the absolute necessity of the existence of a fluid friction. To him, however, we must yield up the priority of invention for this form of coulombmeter.

We have a strong current available, and we will now proceed to test experimentally all these various instruments which you see in the room before you, and which have been designed and constructed in each case to supply an actual need, which our experiments led us to see existed for exact, portable, and moderately cheap measuring instruments for use in electric lighting and electric transmission of power.

THE INDUCTION BALANCE FOR THE DETECTION OF METAL IN THE HUMAN BODY, &c.

BY PROFESSOR A. GRAHAM BELL.*

Professor BELL detailed the various steps taken by him to perfect the induction apparatus, consisting of two flat coils of wire, just invented as the news of the assassination of President Garfield was flashed through America.

Professor NEWCOMB suggested that the presence of the bullet might be indicated by the retardations of a magnetic needle. An experiment was made to discover whether the presence of a leaden bullet would deflect a magnet suspended over it. With the ordinary induction balance the influence of the bullet was not manifested at any distance, and after learning the best theoretical arrangement of coils, coils were made and tried, but no better result was obtained. Various sizes of coils were next tried, and batteries of from one to twenty Bunsen cells, but without appreciable improvement in the hearing distance. The procedure after this was empirical. An instrument was made in which a brass ring took the place of the bullet. The hearing distance increased with the diameter of the primary, and reached a maximum when a secondary coil was placed outside the primary, but not so large. With this instrument the hearing distance was five centimetres. By request of Dr. Bliss an experiment was made on the person of Lieutenant Simpson, who had carried for a number of years a bullet in his back. A sonorous spot was found. The president's medical attendants were communicated with, and they decided that an experiment should be made on the President. Professor Knowland suggested the use of a condenser, and by this means a distinct whistle was heard when the apparatus was placed near a piece of lead. On the 26th July, 1881, the experiment was made, with the following results:—

The telephone gave a peculiar spluttering sound, which could not be lessened by any arrangement of the coils. Passing the apparatus over the lower part of the right side of the President's abdomen a sudden increase of sound was heard, but a repetition of the operation failed to verify this. The failure was due to the condenser. Flattened coils were afterwards used, and the hearing distance increased to 12 centimetres. The two coils were placed in a wooden handle, and a clearly marked sonorous spot was easily discovered on the person of an old soldier. With this apparatus a second experiment was carried out on the President, but the result was fallacious, owing to the steel wire mattress under the bed having been overlooked. The apparatus has undergone several improvements, and now the exact position of a bullet embedded in the human body can be accurately determined. The results point to greater possibilities in the future, and nothing could give the lecturer greater satisfaction than the alleviation of human suffering.

At the same meeting of the section at which the above paper by Professor Bell was read, Mr. T. C. Mendenhall communicated a paper on "The Reduction of the Electrical Resistance of Carbon by the Passage of a Current of Electricity," and Mr. A. E. Dolbear presented two papers, one "On the Construction of Magnets," and the other "On Electrical Conduction *versus* Induction."

* Abstract of a Paper read before Section B of the American Association for the Advancement of Science, Montreal Meeting.

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ON THE ELECTRIC FURNACE.*

BY C. W. SIEMENS, D.C.L., F.R.S., AND A. K. HUNTINGTON, PROFESSOR OF METALLURGY, KING'S COLLEGE, LONDON.

The electric furnace has previously been described in the *Journal of the Society of Telegraph Engineers*, June, 1880. It has since been found advisable to surround the furnace with a coil. By this means the direction of the arc can be regulated at will, and the tendency which it has to fly to the sides of the crucible checked.

The furnace consists of a crucible of any convenient size, in the bottom of which is pierced a hole to receive the positive electrode, the negative electrode, which passes through a hole in the lid of the crucible, being suspended from one end of a beam, the other end of which is attached to a hollow cylinder of soft iron free to move vertically within a solenoid coil of wire. The force with which the cylinder is drawn into the coil can be counterpoised by a sliding weight on the beam. One end of the solenoid coil is connected with the positive, and the other with the negative pole. The coil having a high resistance, its attractive force on the cylinder is proportional to the electromotive force between the electrodes, *i.e.*, to the resistance of the arc. The length of the arc is therefore, regulated automatically. This is a point of great importance, as, were it not so, the resistance of the arc would rapidly diminish as the temperature of the atmosphere within the crucible increased, and the result would be that heat would be developed in the dynamo machine. The extinction of the arc by sudden change in its resistance or by the sinking of the material in the crucible is thus also avoided. The crucible is surrounded with some infusible substance which is also a bad conductor of heat. Gas retort carbon or sand answers well for the purpose. The electrodes may be of such carbon as is used in electric lighting or of any other convenient conducting substance. They may, if desired, be cooled by circulating water through or round them, or by exposing them as far as possible to the air. For example, in one experiment a ½in. nickel positive pole was employed, the lower end being inserted into a solid rod of copper about 1in. square by 6in. long. With this pole (no other means of keeping it cool being adopted) 1lb. of grain nickel was fused in a clay crucible and poured in eight minutes, starting with all cold. The electrode was but little attacked, and no leakage occurred.

There are two great advantages possessed by the electric furnace, viz., that the temperature attainable is practically only limited by the refractoriness of the materials of which the furnace is constructed, and that the heat is developed immediately in the material to be fused, instead of first having to pass through the containing vessel. The temperature to be obtained by the use of fuel is limited by dissociation. Deville has shown that carbonic acid undergoes dissociation at the ordinary atmospheric pressure at about 2,600deg. Cent.—4,700deg. Fah.

In the experiments made by the authors, five D 2 machines driven by a Marshall's 12 horse-power engine were employed; one being used as an exciter. The current ranged between 250 and 300 amperes. The most refractory clay crucibles supplied by the Patent Plumbago Crucible Company were invariably cut through in a few minutes, and, except for experiments of short duration, were useless. Plumbago crucibles stood exceedingly well. Obviously, however, they could not be employed for all purposes, owing to their tendency to cause carburisation of the metal experimented with. In some experiments the fusion of metal was effected in a bed of lime, sand, or electric light carbon dust. The latter is a very bad conductor, and, as in the case of lime and sand, allows the arc when once formed to maintain a passage through it to the metal beneath.

Wrought Iron.—Six pounds of wrought iron were kept under the action of the arc for twenty minutes, and the metal then poured into a mould. It was found to be crystalline, and could not be forged. This is the result which has always been obtained when iron, nickel, or cobalt have been fused. Although the remedy, viz., the addition of a little manganese just before pouring, is well known, the cause remains still unexplained.

Steel.—As much as 20lb. of steel files have been melted in one charge, the time required being one hour, starting with the furnace hot. With such large quantities the metal has invariably been full of blowholes.

White Iron, fused in a clay crucible for thirty minutes, when fractured did not appear to have undergone any change. White iron and coke were introduced into the furnace; the resultant metal was slightly grayer than the original. When, however, retort carbon was substituted for the coke a good gray iron, soft and easily workable, was readily obtained in fifteen minutes, starting with the crucible hot. On another occasion, starting all cold, at the end of thirty minutes the metal, although it had been well fused, had not been rendered grayer. The difference between these two results was possibly due to the temperature being somewhat higher in the one case than in the other. This is a point of considerable practical interest. Four pounds of white iron, fused with carbon dust for three-quarters of an hour, yielded a very gray crystalline iron. In another experiment, in which 8oz. of gray iron, produced in the electric furnace from white iron, were remelted in carbon dust for ten minutes a very gray metal was obtained, from which on slow cooling a large quantity of graphite separated.

Cast iron, fused and kept under the action of the arc for forty-five minutes in carbon dust, was not materially changed as to grayness, and the general character of the metal as to the way in which it worked under the tool was not materially altered. The object of the experiment was to ascertain the maximum amount of carbon iron is capable of taking up under circumstances presumably the most favourable. The result is hardly that which would have been anticipated. Some of the same cast iron was fused for fifteen minutes under lime, which nearly covered it. The character of the fracture of the metal was but little altered by this treatment, when slight differences, due to the rate of cooling, are taken into account. A strong smell of phosphorretted hydrogen or of a phosphide was perceived—probably the latter. This was only observed in the experiment in which lime was used. The lime employed still retains a very offensive odour.

When *spiegeleisen* was fused in a plumbago or a clay crucible graphite separated as the metal cooled.

Siliceous pig iron containing about 10 per cent. silicon was fused by itself, it showed but little change, except that some graphite separated. A similar result was obtained when 5lb. of the siliceous pig were fused for one hour in carbon dust. On fracturing the ingot obtained, a large quantity of scales of graphite was found in a hollow which traversed nearly the whole length of the ingot at its centre. The fracture of the metal was still that so characteristic of highly siliceous iron, and was practically the same as that of the original pig iron.

A series of experiments was made to determine the maximum amount of carbon pig iron is capable of taking up in the presence of a given quantity of silicon. Gray cast iron and pig iron containing 10 per cent of silicon were fused together in carbon dust, the ratio between them being varied so as to yield metal with from ¼ per cent. to 9 per cent. of silicon.

A similar series was made, only substituting sulphur for silicon. No odour of sulphurous acid was perceived; therefore, presumably, no sulphur was volatilised. This is somewhat remarkable, considering the nature of the experiment. It was thought that investigations of this kind might have an important practical as well as more purely scientific interest—admitting, for the sake of argument, that any such distinction really exists—in assisting to determine the conditions in the blast furnace, &c.

Nickel.—A positive pole of this metal—cast malleable by Wiggin and Co.'s process*—½in. in diameter, was passed through a hole in the bottom of a clay crucible. A carbon negative pole was used, but soon after the commencement of the experiment a deposit of nickel formed on the end of it, so that practically it was a nickel pole. This deposition of

* Read before Section B of the British Association at Southampton.

* See paper on "Nickel and Cobalt," by A. K. Huntington, in July number of the *Journal of the Society of Chemical Industry*.

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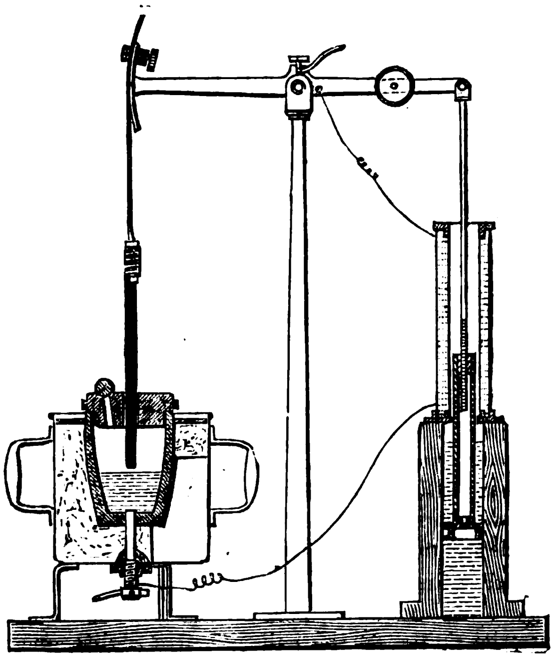
metal on the negative pole was also observed with some other metals—notably with tungsten. Whilst disclaiming any special knowledge on the point, Professor Huntington suggested whether this phenomenon—which is the reverse of that generally recognised as taking place—might not depend on the relative volatility of the matter composing the poles. In the furnace arranged as just described, 1lb. of grain nickel was fused and poured in eight minutes. The fused metal had a brilliant granular fracture. It could not be cut properly in the shaping machine, shearing off under the tool. One pound of grain nickel fused in carbon dust for twenty-five minutes yielded a dark gray carburised metal, which worked well under the tool. On another occasion an equal quantity of nickel, similarly treated, gave a "blowy" metal, which could not be worked. Some carburised nickel, made as described above, was fused in a clay crucible for twelve minutes, and allowed to cool gradually in the furnace; the fracture became whiter, and the grain closer.



Siemens' Electric Furnace.

Copper.—Three-quarters of a pound of copper were fused for about half an hour in carbon dust. On examining the result, it was found that all but about ¼oz. had been vapourised. Those who were present during the experiments suffered no ill-effects from the atmosphere charged with copper, which they must have breathed.

Platinum.—Eight pounds of platinum were rendered perfectly liquid in about a quarter of an hour.

Tungsten.—Half a pound of tungsten in powder was subjected to the action of the arc in a clay crucible. Dense fumes were evolved, a cavity about 1½in. across the top being formed. The furnace was allowed to cool down slowly. When the crucible was removed, it was found to have been very much attacked below the point to which the arc extended. The inference is that the crucible had been attacked by the metal at the temperature of the experiment. The metal was fused only to an inappreciable depth beneath the cavity formed by the arc. The unfused metal underneath was covered with very beautiful iridescent crystals of tungsten, which under the microscope appeared to be well-formed prisms. They have not yet been measured. The crystals had evidently been formed by the slow cooling of the vapour distilled down from the surface.

A very large number of experiments was made with tungsten, the results of which showed that it could not be fused, except in very small quantities at a time. It was possible to build up a small ingot by fusing a little of the tungsten, and then adding little by little gradually. Even then the pieces obtained were for the most part spongy and unsatisfactory. The best results arrived at were when tungsten which had already been fused was employed in the building-up process. Once the metal had been fused, it did not fume much in melting, doubtless owing to the greatly reduced surface exposed.

Tungsten fused in the electric furnace is, when untarnished, pure white, and brittle, the grain being very close. Tungsten hitherto has only been obtained as a gray powder, by reducing the oxide with carbon or hydrogen, or in minute globules in the ordinary small electric arc. Tungsten has its fusing point lowered by the addition to it of carbon. Under these conditions a solid piece of moderate size can, without much difficulty, be obtained. From 1,000 grains of powder fused in carbon dust 650 grains were recovered, the remainder having been volatilised, and from 450 grains of the fused metal 410 grains were obtained on refusion. One piece of tungsten which had been treated under the conditions most likely to cause it to be highly carburised was analysed. It contained 1·8 per cent. of carbon. The metal was very white, close in grain, and brittle.

From the foregoing experiments it is clear that the amount of any given metal which can be successfully fused in the electric furnace, and the time required in effecting the fusion, are dependent on (*a*) the relation between the volatilising point and the fusing point, *i.e.*, the extent to which the volatilising point is higher than the fusing point; (*b*) the conductivity of the metal for heat.

It thus happens that platinum can be more readily melted than steel, and in greater quantity for a given expenditure of energy. This inference is believed by Professor Huntington to be justified by the observations and experiments so far made.

It still remains to examine chemically the specimens referred to in this paper.

In the discussion on the communication made by Professor Huntington, Dr. Siemens remarked that the limit of the temperature producible by means of the electric furnace is as yet unknown, for although the heat would probably increase the resistance of the arc, that in itself would only cause a further development of heat. The results obtained with copper, although apparently pointing to a drawback in the use of the furnace for melting purposes, yet might prove of importance in dealing with metals in the vaporous condition. He could not agree with Professor Huntington's suggestion as to the cause of the deposition of metal on the negative pole. He thought it was due to the negative pole being much cooler than the positive.

Dr. Gladstone inquired whether the deposit was crystalline or in fused globules.

Professor Huntington replied that it was in the latter condition.

Mr. Terrill (Swansea) remarked that the loss of copper by volatilisation in smelting was much greater than it was generally supposed. During an accidental escape of sulphuretted hydrogen in the works he had observed a thick deposit of sulphide of copper extending over a large area. He had detected copper deposited even on the zinc counter of the refreshment bar at the railway station some distance from the works. The discussion was continued by Mr. Maxwell Lyte, Professor Vernon Harcourt, and the president, Professor Liveing, who thought that such experiments as had been made might be of great service in the study of metals.

ON THE DURATION OF FREE ELECTRIC CURRENTS IN A CONDUCTING CYLINDER.*

BY LORD RAYLEIGH.

This paper was devoted to considering the rate of decay of currents of electricity circulating round a conducting cylinder. The time in which the intensity sinks from e to 1 is called the "time of subsidence." For a copper cylinder of r centimetres radius, this is equal to $r^2/800$. That this may be one second, the diameter of the cylinder must be two feet.

* Abstract of a paper read at the Southampton meeting of the British Association.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 396, *Strand, London, W.C.*

We cannot undertake to return drawings or manuscripts, and must, therefore, request Correspondents to keep copies.

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SCIENTIFIC JOURNALISM AND THE LAW OF LIBEL.

Of the many regrettable consequences likely to follow on the feverish and widespread speculation in electric lighting property not the least, perhaps, is the discredit into which scientific journalism is in danger of falling. Already it has been accused in more quarters than one of failing in its duty towards the public, of withholding trustworthy statistics, or of neglecting to point the moral of such few as have already been published—of, in short, declining to act as umpires between the inventors and their clients. Whether the discharge of functions of this kind is part of the obligation imposed upon technical newspapers may be a subject for fair argument, and it is one from the discussion of which we certainly should not shrink. It is clear, however, that our non-technical critics who so freely charge us—unfairly as we think—with want of due solicitude for the interests of a speculative public have not duly considered what might be the consequences to us of taking those interests specially under our protection. One such consequence has just overtaken us, and before entering upon the general question we may, perhaps, be permitted to make a few remarks upon the particular one.

The reader of the daily papers may have noticed under the heading of Law Intelligence that an injunction was lately sought and subsequently obtained against *The Electrician* for an alleged libel, and prohibiting the sale of copies containing it pending the trial of an action at law. We have refrained, and still do refrain, from referring specifically to the libel complained of, because we have no wish to give further publicity to anything that may be reasonably objected to in our columns, even if it were proved to be strictly within our legal rights. We mention it now in order to state once and for all that in the case complained of, as in every other of a similar kind, we have been actuated simply by a desire to afford opportunity for discussing the merits of inventions coming within the purview of this paper, but we entirely disclaim all responsibility for the views and statements of our correspondents. Personally we had no views as to the validity or not of the particular invention criticised. A letter, however, reached us for publication, the *bona fides* of which could not be doubted. We accordingly published it, expecting an answer to it, and of course intending to publish that also. We, however, received an intimation that proceedings had been taken against us for libel. We do not complain of that; the aggrieved party is clearly within his rights in testing by legal means whether the letter in question exceeded the bounds of fair criticism. What we do regret is that we should have inadvertently said or done anything capable of being so seriously taken to heart as to be thought deserving of pains and penalties, when we had not the slightest intention in any way to interfere with questions of patent rights, or to support any one side in the case of conflicting views. The letter in question was simply admitted as expressing the view of the correspondent, and not in any way that of the paper.

We say that an aggrieved person in these circumstances is acting within his rights; but the question still remains, What are the rights of journalism? Its rights, one would imagine, are comprehended in its duties. But the newspapers tell us that our duty is one thing, the law courts may tell us that it is quite another, or possibly that rights and duties are not interchangeable terms in legal estimation. And it must be confessed that a supposed right to injure one person is not always to be measured by an assumed duty towards some other person. What the newspapers mean, and what probably they would assist us in upholding is that, when the duty is obvious and paramount—as for example when it nearly concerns the public welfare—the right to perform it should not be interfered with by considerations of personal damage. It is seldom indeed in this world that one's duty can be thoroughly done without directly or indirectly injuring somebody. Society, however, usually condones the lesser evil for the sake of the greater good. We are not more quixotic than our neighbours, but we have always regarded it as part of our duty to our readers, and to the public generally so far as we can reach them, to suppress nothing that may benefit them either in the way of warning or advice. Our difficulty has been to obtain trustworthy information, not our unwillingness to publish it. But when we do publish it we count upon being protected by the law which regulates all human affairs—the law, namely, of fair play for everybody.

At the present moment the chief subject of anxiety is the validity of patents relating to electric lighting. The proprietary rights of one set of owners are always being menaced by the owners of conflicting rights;

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and as immense sums of money depend upon the issue of these contentions, it is natural that every outspoken criticism should be keenly scanned in view of its effect upon the money market. It is natural, also, that when such criticism feels itself justified in saying that one proprietary right is an infringement of somebody else's, considerable wrath is aroused. But we have had occasion to say as much as that over and over again in respect to patents taken out in recent years, and so long as we have said it in good faith, on reasonable grounds, and with no intentional malice, we have held that we are within, not merely the moral duties, for they cannot be doubted, but the legal rights of a technical journal.

In maintaining this opinion, of course we speak as journalists, not as lawyers; but even from a legal point of view we have hitherto believed we were in the right. It has been ruled on more than one occasion, in cases relating to patents, that a patentee is not merely privileged, but is bound to apprise the public of any infringement of his patent—this in the public interest as well as his own. Under such privilege various advertisements have only quite recently appeared in the public prints. All these announcements virtually prejudge the question which is about to be submitted to a law court for decision. But they are permitted, and what is right and proper for them can hardly be denied to the equally *bonâ fide* opinions of a scientific journal. That, at all events, is our view. We may be wrong; but if we are, the public alone will be the sufferers, and they must no longer look to journals such as ours to help them in judging the merits of any new invention that solicits their admiration—and their cash.

CORRESPONDENCE.

ON AN ENERGY METER AND THE INTEGRATION OF VARIABLE QUANTITIES BY MEANS OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The only examples of the above principle, to my knowledge, being Messrs. Sprague and Edison's current meters, I venture to point out to your readers how a depositing cell can be made to integrate any variable force, however weak or strong.

If the current in a depositing cell be, by some means, made to vary with a force, the amount deposited will be some function of the integral of that force.

I found it was not practical to make the strength of depositing current vary directly as the force, either by causing the latter to vary the resistance in an inverse ratio or the electromotive force directly, the first requiring the resistance to be diminished as the ordinates of a rectangular hyperbola in which the abscissæ represent the force acting; and the second, which in theory might be done by something on the principle of Clarke's potentiometer, is impracticable, because the current would not vary simply as the distance, y, a point had moved, but as

$$\frac{a\,y}{b + y - y^2},$$

where a and b are constants.

I then tried making the resistance vary directly, therefore the current inversely, as the force, and this I found to be perfectly practicable.

Let C (Fig. 1) be a large constant battery whose E.M.F. = E,

D be a depositing cell, with low internal resistance.

By some means make the resistance A x = R increase directly as the force F to be measured, so that when F = O R = O, and the remaining resistance of the circuit call r, whose value may be determined by means of a low resistance galvanometer and an ohm coil, such as is used in determining the constant of Ayrton and Perry's ammeter.

Let T = time of experiment in minutes,
C = deposting current in amperes,
Q = C T = number of ampere minutes,
D = the amount deposited,
d = the amount that would be deposited in an ampere minute, which, of course, is known, and depends on the electrolyte used, generally a salt of copper or silver.

FIG. 1.

Let F be the force which at any moment is being registered, and as R is to vary as F, R may be put = a F, and if F be expressed in foot pounds a minute, a will equal the resistance in ohms inserted in the depositing circuit for every foot pound of energy passing.

Then $Q = \frac{D}{d} = CT$, therefore C, the average current during the time T, $= \frac{D}{d\,T} = \frac{E}{R + r}$, and the mean value of R will $= \frac{E}{C} - r = \frac{E\,d\,T}{D} - r$.

Therefore the mean value of F will be

$$= \frac{1}{a}\left(\frac{E\,d\,T}{D} - r\right),$$

and the integral of the force during the time T

$$\text{will} = \frac{T}{a}\left(\frac{E\,d\,T}{D} - r\right).$$

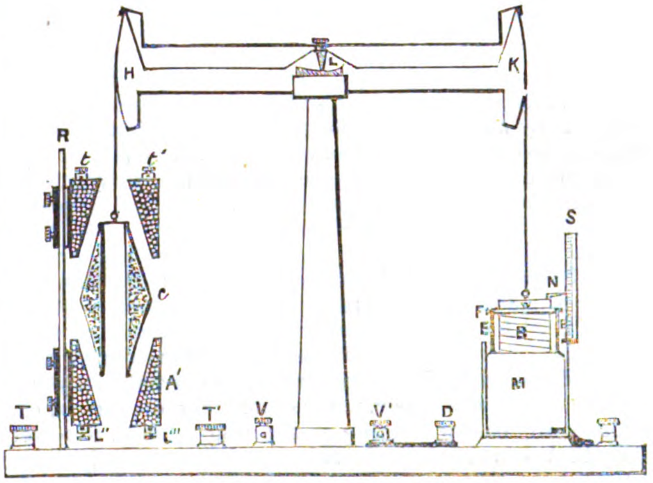

FIG. 2.—Electric Energy Meter.

Fig. 2 shows how the above principle can be applied to an electrical energy meter. In order to get a long range of movement, and this is nearly proportional as possible to the energy, I wind the fine wire solenoid on a half-inch ebonite tube, in the form of a double cone C. This being wound in two sections of 500 ohms, the resistance can either be mad 1,000 or 250. The solenoid C is acted on by two thick wire hollow conical coils, A and A′, so wound that the upper repels, while the lower one attracts C. They are supported by the rod R, so as to allow of adjustment to the proper distance and position. They are shown in section in Fig. 2, their length is half that of C. The ends and outside are made of sheet iron, as in Mr. Boy's solenoids, with longitudinal slits to prevent induction currents circulating, when rapidly varying energy is being measured. The thick coils' terminals

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t, *t'*, L'', L''', connected up either in series or multiple arc, are joined to the main terminals T and T'.

The fine wire coil C is hung from one end of an ebonite beam, H K, with circular ends, by two fine steel wires, which convey the current through C to and from two insulated knife edges, L, which, resting on metallic blocks, transmit the current to and from the terminals V and V'.

From the other end of the beam the resistance cylinder B is hung by a fine steel wire, W K, in connection with one of the knife edges, thereby with the outer terminal. W is an iron weight just sufficient to balance the coil C. On the cylinder B, which is fastened to W, is wound spirally a fine platinum wire, whose upper end is electrically connected to the supporting wire W B. The cylinder B dips into a glass jar filled with mercury connected to the terminal D. The lengths of the supporting wires are so adjusted that, when the top end of C is on a level with the top end of the upper conical coil, the flange F just touches the surface of the mercury M. The pointer N moving in front of a scale S shows the energy passing at any moment.

As the force between the solenoids is very small; in my case not exceeding one grain for every volt ampere, or watt, as I suppose it will be now called, it is necessary to make the force required to lift B out of the mercury a proportionally small positive quantity. The best way of doing this is to cause the cylinder to have its specific gravity very slightly in excess of that of mercury, which is 13·5, by making it of thin platinum foil whose specific gravity is 22, with flanges at both ends to add to its rigidity, and covering it with a very thin layer of paper. If the weight be now so adjusted that when no energy is passing the cylinder B hangs entirely immersed in mercury, a very little power will lift it up. Should this be too sensitive, thin strips of ebonite, E E^1, can be fastened on the flange F extending downwards the whole length of the cylinder, and a few grains weight be added to W to restore the balance. This will reduce the sensitiveness to any degree, according to the volume of the ebonite strips added. There is a very small hole at the top end of the cylinder to admit air very slowly, in order to prevent sudden movements.

Having got the instrument properly balanced, it is necessary to obtain the calibration curve, so as to be able to divide the cylinder by horizontal lines, between which equal lengths of platinum wire are to be wound. The curve once obtained will be correct for any degree of sensibility. To draw the calibration curve, the current through the fixed coils must be varied by known amounts, while the terminals V and V' are connected to a constant number of cells, or *vice versâ*, or by varying both. I use a large lead storage battery for the thick coils, and connect different numbers of small chloride of silver cells to the terminals V and V'.

I take this opportunity of reminding your readers how extremely convenient and constant the silver cells are. Last October I made up four sets of ten, and although very frequently used for testing insulation of leads, calibrating different instruments, and sundry experiments requiring a constant and known E.M.F. and very small current, they work as well now as when new. For cleanliness, constancy, compactness, and ease in making and setting up, they are everything that can be desired, and as each set certainly did not cost me more than six shillings to make, they are a wonderfully cheap battery. Of course, the quantity of Ag Cl in each cell is very small, but so is the amount of current required.

But to return. Let A B C (Fig. 3) be the calibration curve, and A Y represent the length of cylinder. Then the ordinates will represent the distances the cylinder is lifted for different values of energy represented by the corresponding abscissæ A X. By drawing a number of equi-distant ordinates to points in the curve, and through these lines parallel to A X, A Y will be divided into parts between which equal resistances must be wound. Should the double-coned solenoid be used, the curve A B C will be very nearly a straight line. If the cylinder be four inches long, and have a circumference of three inches, 10 feet of platinum wire could be wound on it, 10 turns being, on the average, wound in an inch. For experiments of long duration the finest platinum wire should be used, and have a resistance of 20 to 30 ohms to the foot, but for testing the amount of energy absorbed and given out by storage batteries—and it was for this purpose that the instrument was originally intended—thick wire should be used with a resistance of four to five ohms to the foot. While the cylinder is being wound with wire it should be blocked with a wooden cylinder inside to keep the shape from being destroyed.

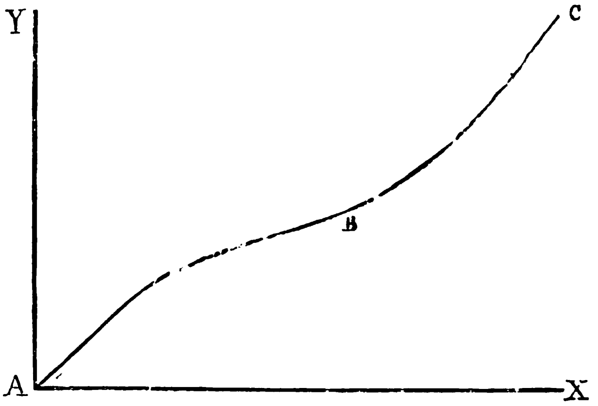

Fig. 3

Fig. 4 represents the instrument and connections when used to register the external energy given out by a battery of storage cells, F, through a lamp, L. M is a train of clockwork to register the time the current is flowing. This is released by a small thick wire magnet, N, through which the main current passes; this also connects up the depositing circuit by the contact points S and R. G is a depositing cell with small plates placed close together. B is a large and constant Daniell or chloride of silver cell. When the current passes through the lamp the clock is started, and the depositing circuit is closed, but when the main current ceases to flow the clock is stopped, and the circuit through G is broken.

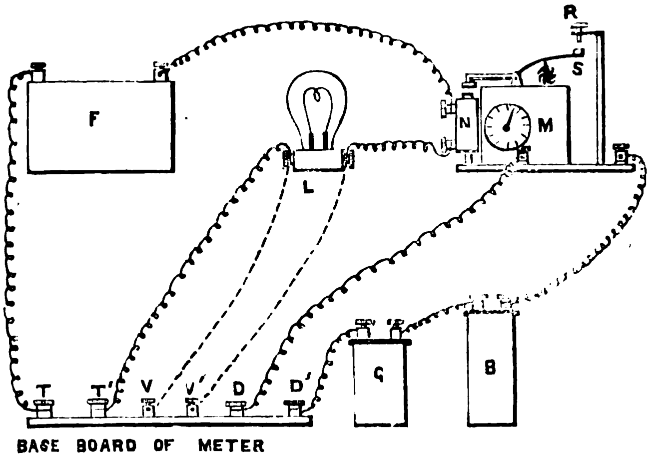

Fig. 4.—Diagram of Connections with Meter.

And in like manner the variable resistance cylinder may be used to integrate any kind of variable quantity, or to give the average value of such varying elements as height of barometer, temperature, speed, steam pressure, and a great many other variables.—Yours, &c., Arthur Wright.

Brighton, September 1, 1882.

SMALL COMPOUND CONDENSING ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Various statements having been made from time to time as to the consumption of coal in small engines such as would be used for an installation of electric light requiring from 10 to 20 horse-power, I take the opportunity of sending you particulars of a trial of an engine and boiler on Kingdon's patent. The engine was of the compound condensing type, and consisted of a pair of small high pressure cylinders

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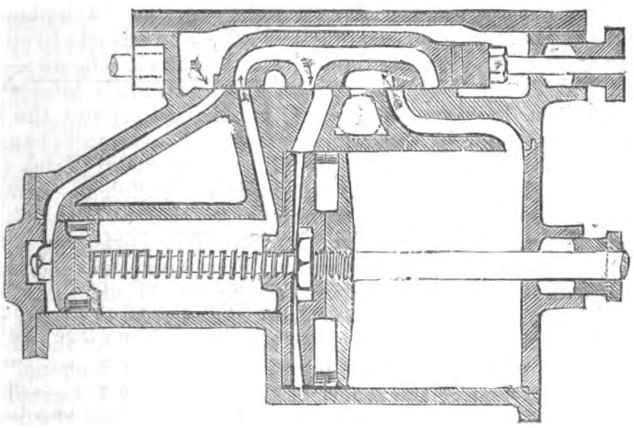
fixed on the top of a pair of low pressure. The grade of expansion was directly proportional to the area of the two cylinders, the leakage from one to the other being prevented by the simple expedient of turning grooves in the piston rod connecting the two pistons. So far the novelty is not striking, but when the fact is ascertained that all these engines, from the very smallest size, are fitted with a condenser and an air pump working at the same piston speed as the main engine, it will be seen that they differ very widely from the ordinary tandem type. The engine I experimented with was fitted in a launch, and had a pair of 3½in. diameter high pressure cylinders and two 7in. low pressure. The steam, after performing its work in the cylinders, was led through a pipe outside the boat, and condensed, the water being lifted by a small air pump into a miniature hot well, whence it ran into a feed pump, also worked direct, having very ingenious self-acting valves, and was forced into the boiler. Theoretically there should be no waste, and the difficulty of keeping the water level constant is removed. In



Cylinders of Kingdon's Compound Engine.

practice it is found necessary to renew the small amount due to leakage, but in a four hours' trial I found no variation of the water line. The pressure averaged 60lb., revolutions 286, the vacuum 26in. *The consumption of coal was under 2lb.* per indicated horse-power per hour. The boiler calls for no special remark, with the exception that owing to the very large fire grate area it was not found necessary to open the fire-door for the first hour and a quarter's run.

Although such a simple means of condensing is not always available on land, the inventor informs me a very small jet of water gives equally good results, and my own experience with air condensing shows it is practicable. With the reduced price of gas, economy in the motor must be looked for by all well wishers of the electric light, and must be my excuse for trespassing on your valuable space.—Yours, &c.,

Westminster, S.W. KILLINGWORTH HEDGES.

INFLUENCE OF THE POSITIVE ELECTRODE IN A BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The influence of the positive electrode on the chemical work of a battery as investigated by MM. Tommasi and Berthelot is a subject of much importance, and as having some bearing upon it the following note may be found worthy of being placed upon record, if not for the practical interest it may have for many of your readers.

For the purpose of comparatively determining the strength of currents of low tension given by various secondary batteries, I have during a lengthy series of experiments employed a voltameter in which one of the platinum electrodes ordinarily used is replaced by copper. With such a voltameter, currents incapable of decomposing acidulated water using platinum electrodes may be conveniently measured from the hydrogen collected. The electromotive force required to decompose the dilute sulphuric acid is, of course, constant only in the case last referred to. The E.M.F. of the battery currents is supplemented by the energy of the chemical affinity of copper for oxygen.

For experimental studies, and in the absence of expensive apparatus, this method of testing low tension currents furnished by small accumulators is of some considerable utility.

It, of course, admits of elaboration by using other metals in the place of copper, so that the particular metal necessary in order to obtain decomposition of the water may indicate at once the approximate strength of the current being tested.—Yours, &c., C. T. KINGZETT.

17, Lansdowne-road, Tottenham, N.
September 11, 1882.

MEYER'S SYSTEM OF UNDERGROUND MAINS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent "Engineer" has drawn attention to the importance of special companies being formed for laying and letting underground mains of wires for the use of electric light, power, telephone, and telegraph companies. This is what I pointed out in my pamphlet on the "Development of Electricity," and I claim credit for having been the first to make the suggestion. If electric light and power are ever to be supplied to the public on a large scale, I believe there is no other way of meeting the difficulty and expense which the laying of subterranean mains must necessarily incur.

The cost of breaking up streets and the interruption to traffic is as great for the laying of 100 wires as for 1,000, and the relative cost of materials per wire for insulating and protecting conductors steadily *decreases* as the number of conductors contained in the main gets larger. This is undoubted fact, and it is quite evident, therefore, that a company owning 1,000 wires running a certain distance could afford to charge only half for the use of its wires, and still get the same interest on the capital laid out, as against 10 companies, each laying a main of 100 wires each.

But there is another advantage to be gained. Assuming a town to have been planned out into districts, and mains to have been laid between the various centres, which were, therefore, in direct connection with each other, if a main from any cause whatever became interrupted, the supply of electric force to the district so cut off could still be kept up by sending it through another centre. This, of course, on the assumption that all conductors in the town belong to one concern.

Electric light will have uphill work to compete with gas for domestic lighting, and its opponents will make the most of any accidental extinguishing of the light; indeed, the fear of this will deter many people from adopting it, until they are convinced by experience, that they run no risk of being left in the dark. An alternative route for supplying a district should, therefore, be one of the first considerations of a company undertaking a public supply, and this can hardly be done in any better way than that which I suggest.—Yours, &c., H. R. MEYER.

B 12, Exchange Buildings, Liverpool,
September 12, 1882.

EDISON'S SYSTEM OF ELECTRIC DISTRIBUTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you kindly allow me to call attention to, and correct, a few errors in the edition of September 2nd. Page 380, equation of dotted curve should be $C' = \frac{c}{r}$; page 381, second column, line 14, should read, "This, I think, will be the future light *for very high power.*" Line 31 should read, "This is considering the kind of machine I think necessary, &c."—Yours, &c., F. J. SPRAGUE.

September 7, 1882.

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TELEGRAPHING WITHOUT WIRES.

The *Dundee Advertiser* of September 6 has the following:—

At the British Association meetings at Southampton, Mr. W. H. Preece, electrician at the General Post Office, adverted, in a paper on "Telephones," to an experiment he had made of telegraphing from the mainland to the Isle of Wight without employing a cable across the intervening space of water. This he accomplished by utilising the property of electricity named induction. The efficiency of the telephone is frequently interfered with by currents of electricity being "induced" in the telephone wire by the electricity in telegraph wires, and Mr. Preece conceived the idea that as induction takes place sometimes in wires which are several miles apart, use might be made of this property to dispense with wires in certain cases. The purpose of wires is to carry the electric current, but if the current were ready to travel of its own accord without wires the saving in maintaining telegraphic communications would be very great. This idea, however, is not a novel one. At the meeting of the British Association held in Aberdeen in 1859, the late Mr. J. B. Lindsay, of Dundee, read a paper, in which he described experiments almost as extensive and precisely the same in their method as that explained by Mr. Preece at Southampton the other day. In the days when our achievements with electricity are deemed so considerable, the humbler efforts of Mr. Lindsay are apt to be forgotten. There is no doubt, however, that he foresaw much that has only been accomplished within the last few years. His inventive faculty was keen, and he possessed the energy and perseverance, though unfortunately not always the resources, to work out his inventions. His studious disposition was remarkable, and if his talents had been developed in a sphere more suitable for them than the banks of the Tay his name might have become famous in the annals of science. His prescience is exhibited in the following paragraph, which is taken from the *Dundee Advertiser* of August 7, 1835. It describes all the virtues of the electric light with as great completeness as though it had been written of a discovery by Edison or Swan:—"Mr. Lindsay, a teacher in town, formerly a lecturer to the Watt Institution, succeeded, on the evening of Saturday, the 25th ultimo, in obtaining a constant electric light. It is upwards of two years since he turned his attention to the subject, but much of that time has been devoted to other avocations. The light, in beauty, surpasses all others, has no smell, emits no smoke, is incapable of explosion, and, not requiring air, can be kept in sealed glass jars. It ignites without the aid of a taper, and seems peculiarly adapted for flax houses, spinning mills, and other places containing combustible materials. It can be sent to any convenient distance, and the apparatus for producing it may be contained in a common chest."

In 1836 Mr. Lindsay lectured on the electric light, and stated that as early as 1831 he had turned his attention to the subject. In a letter published by him in 1845 he suggested the possibility of laying an electric cable across the Atlantic, a dozen years before the project was seriously entertained. Afterwards he developed a scheme for telegraphing across oceans without cables. He lectured at Glasgow in 1853 on his theory of forming an electric communication between Great Britain and other countries without the employment of submarine wires, and the cost of such communication to America he calculated to be £60,000. A patent for his scheme was taken out in 1854, and several experiments were made by him at different places. The following paragraph appeared in the *Dundee Advertiser* of May 20, 1859:—

"Electric Telegraphing Across the Tay without Wires.—We have received the following note from Mr. J. B. Lindsay reporting progress with his experiments. The results, it will be seen, are highly encouraging: 'Yesterday (May 17) I telegraphed successfully across the Tay opposite to Glencarse, where itis about half-a-mile broad. The action on the needle was strong, and the same battery power would cross, I think, at Broughty Ferry.'"

The dock authorities at Liverpool invited him to exhibit his invention on the Mersey, but, owing to his apparatus having been deranged, his experiment in England was not successful. This caused scepticism as to the merits of the discovery, and he made renewed tests with it on an extended scale on the Tay. These fully realised his expectations. The *Dundee Advertiser* of July 10, 1860, contained a letter to the editor, in which Mr. Lindsay wrote:—"During last week I was engaged in making a telegraphic experiment across the Tay below the Earn, at a place where the river is more than a mile broad. The experiment was successful, and the needle was strongly moved, but, as I had no person with me capable of sending or reading a message, it was not attempted."

Meanwhile he had exhibited his scheme to the *savants* of the British Association at the meeting in Abeerdeen in 1859. Experiments were made with it across the river Dee, and he read a paper describing its theory to the Mathematical Section, in the debate on which Lord Rosse, chairman of the section, and other leading scientists took part. Before quoting the condensed report of this paper, it may be well to quote the passage in Mr. Preece's paper on "Telephones" read at Southampton last week, in which he adverts to an experiment exactly on the lines of Mr. Lindsay's scheme:—

"Mr. Preece had recently tried an extremely interesting experiment between this place (Southampton) and the Isle of Wight—namely, to communicate across seas and channels without the aid of wires at all. Large metal plates were immersed in the sea at opposite ends of the Solent—namely, at Portsmouth and Ryde, six miles apart, and at Hurst Castle and Sconce Point, one mile apart. The Portsmouth and Hurst Castle plates were connected by a wire passing through Southampton, and the Ryde and Sconce Point plates by a wire through Newport; the circuit was completed by the sea, and signals were passed easily so as to read by the Morse system, but speech was not practical with the telephone."

The following is the report of the paper on "Telegraphing without Wires," read by Mr. J. B. Lindsay to the Mathematical Section of the British Association, at its meeting in Aberdeen, in September, 1859, which appeared in the *Dundee Advertiser*. After relating various minor experiments, he proceeded to describe his process, saying:—

"Recently he had made additional experiments, and succeeded in crossing the Tay where it was three-quarters of a mile broad. His method had always been to immerse two plates or sheets of metal on the one side, and connect them by a wire passing through a coil to move a needle, and to have on the other side two sheets similarly connected, and nearly opposite the two former. Experiments had shown that only a fractional part of the electricity generated goes across, and that the quantity that thus goes across can be increased in four ways:—First, by an increased battery power; second, by increasing the surface of the immersed sheet; third, by increasing the coil that moves the receiving needle; and, fourth, by increasing the lateral distance. In cases where lateral distance could be got he recommended increasing it, as by that means a smaller battery was requisite. In telegraphing by this method to Ireland or France abundance of lateral distance could be got, but for America the lateral distance in Britain was much less than the distance across. In the greater part of his experiments the distance at the side had been double the distance across; but in the experiments in the Tay the lateral distance was the smaller, being only about half-a-mile, while the distance across was three-quarters of a mile. Of the four elements above-mentioned he thought that if any one were doubled the quantity of electricity that crossed would also be doubled; and if all the elements were doubled the quantity transmitted would be eight times as great. In the experiment across the Tay the battery was of four square feet of zinc, the immersed sheets contained about ninety square feet, the weight of the copper coil was about 6lbs.; the lateral distance was less than the transverse distance, but if it had been a mile, and the distance across also a mile, the signal would no doubt have been equally distinct. Should the above law (when the lateral distance is equal to the transverse) be found correct, the undermentioned table might then be formed.

"But supposing the lateral distance to be only half the

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transverse, then the distance crossed might be 16,000 miles, and if it was only a fourth, then there would be 8,000 miles, and thus a greater distance than the breadth of the Atlantic. Farther experiments were, however, necessary to determine the law. Since last experiment he had increased the coil, and thought there was power to come two miles. According to this calculation, he thought a battery of 130 square feet, immersed sheets of 3,000 square feet, a coil of 200lbs. weight were sufficient to cross the Atlantic with the lateral distance that could be obtained in Great Britain."

The following is the table above referred to :—

Zinc for Battery.	Immersed Sheets.	Coil.	Distance Crossed.
4 sq. ft.	90 sq. ft.	6 lbs.	1 mile.
8 ,,	180 ,,	12 ,,	8 ,,
16 ,,	360 ,,	24 ,,	64 ,,
32 ,,	720 ,,	48 ,,	512 ,,
64 ,,	1,440 ,,	96 ,,	4.096 ,,
128 ,,	2,880 ,,	192 ,,	32,763 ,,

If Mr. Lindsay's hopes are to be realised, some great discovery yet remains to be made, for by the laying of the Atlantic telegraph cables we know that the electric current transmitted across the wide expanse of the Atlantic must be of extraordinary power to be apparent on the other side, even with a cable to lead it. Without a cable it would be hopeless to expect to find it, although the best apparatus were employed. Telegraphic instruments are greatly improved since Mr. Lindsay worked with them, and as regards batteries and coils he would find available for his purpose all that he could wish. No currents, however, are in use which would induce another current 2,000 or 3,000 miles away. Still it is within possibility that such may be found, and to a Dundonian must be ascribed the honour of having first conceived the scheme of transoceanic telegraph communication without the aid of cables.

REPORT ON THE ULTRA-VIOLET SPARK-SPECTRA EMITTED BY METALLIC ELEMENTS AND THEIR COMBINATIONS UNDER VARYING CONDITIONS.*

The object of this investigation was to give, first, a means of readily identifying the metals by photographs of their line spectra; secondly, a knowledge of the alterations producible in the spectra of metallic salts by the presence of various non-metallic elements; thirdly, a knowledge of the alterations caused by the dilution of metallic solutions; fourthly, a possible means of performing rapid quantitative determination of metallic substances by the aid of photography, and obtaining permanent records of the results. These objects have been more or less completely attained, and the results obtained have been the subject of two communications to the Royal Society, which contain an account of the elucidation of the following points:—(1) The solution of the practical difficulty of obtaining photographs of spark spectra of metallic salts from their solutions; (2) the comparison of spectra yielded by metallic electrodes with those obtained from saline solutions; (3) the variations in the spectra caused by dilution of saline solutions; (4) the sensitiveness of spectrum reactions under certain conditions; (5) the variation in the spectra of metals caused by alterations in the intensity of the spark employed. A comparison of the spectra of solution of salts with those of metallic electrodes show that in almost all cases the lines of the metals were produced from the solutions. The non-metallic constituents of salts do not yield any marked series of lines. The spectrum of aluminium, as obtained from pure solutions, is free from a group of short or discontinuous lines, which the author has shown to be due to iron. In estimating the relative proportions of the constituents of alloys or minerals, only those methods are to be recommended in which solutions are used, as in this way the non-homogeneity of the substance under investigation can alone be obviated. With regard to the reversal of metallic lines, it is pointed out that over-exposure suffices to produce reversal without materially influencing the rest of the spectrum; and in order to obviate this result, it is recommended that comparative exposures should be methodically employed to confirm the accuracy of observations made entirely by the aid of photographic representations and of spectra. This is especially the case where gelatine or other dry plates containing organic matter are employed.

* Presented to the Southampton meeting of the British Association by Professors Odling, Huntington, and Hartley.

ON THE ABSOLUTE MEASUREMENT OF ELECTRIC CURRENTS.*

BY LORD RAYLEIGH.

The absolute measurement of current is more difficult than that of resistance. All the methods hitherto employed require either accurate measurements of the horizontal intensity of the earth's magnetism or of coils of small radius and many turns. This latter is difficult to evaluate, as it is impossible to measure the length of the wire wound, as the tension necessary to make the wire lie evenly stretches it very considerably, whilst it is most important to determine the mean radius accurately, as an error therein doubles itself in the final result. The method of Kohlrausch is free from this objection, but it requires a knowledge of the moment of inertia—a quantity not easy accurately to determine. When the electro-magnetic action is a simple force it can be determined directly. In Mascart's recent determination a large solenoid is suspended vertically in a balance, and is acted on by a flat co-axal coil of much larger radius. This is simple to think about, but not calculated to secure precise results. The appearance of accuracy is illusory, unless it can be assumed that the distribution of wire is absolutely uniform. It would appear that all the turns of the suspended coil should operate as much as possible, that is that the suspended coil should be compact, and should be placed in the position of maximum effect. There is a further incidental advantage in this arrangement. The expression for the attraction involves as factors the product of the number of turns, the square of the current, and a function of the mean radii of the two coils, and of the distance between their mean planes. This function is of no dimensions. When the position is such that the function for two given coils is a maximum, the result is practically dependent only on the two mean radii, and the function being of no dimensions, can involve these mean radii only in the form of a ratio. This can be obtained electrically with full precision by dividing a current between them in such a way that no effect is produced on a small magnet at their common centre. In practice it will be desirable to duplicate the fixed coil, placing the suspended coil midway between two similar fixed ones, through which the current passes in opposite directions.

ON THE EQUILIBRIUM OF LIQUID-CONDUCTING SURFACES CHARGED WITH ELECTRICITY.*

BY LORD RAYLEIGH.

This was a mathematical paper in which was investigated the condition of stability of a sphere of fluid charged with electricity. If Q be the charge, T the surface tension of the fluid, and a the radius of the sphere, then the condition of stability is that $T > Q^2/16\pi a^3$.

VISION BY THE LIGHT OF THE ELECTRIC SPARK.†

BY W. LECONTE STEVENS.

This paper gave the result of a series of experiments in stereoscopy from a pair of perfectly similar figures viewed by the momentary illumination of an electric spark. The stereoscope used was a reflecting one, such as is used to

* Abstracts of papers read at British Association meeting, Southampton.

† A paper read at the Montreal Meeting of the American Association for the Advancement of Science.

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denote the value of the optic angle that results from any possible relations between the visual lines of a pair of eyes. Vision may thus be made normal or abnormal at will. The use of the spark in the study of binocular vision is no novelty, but seems not to have been employed hitherto in studying abnormal vision with the visional lines divergent on the peculiar mode of stereoscopy recently devised. The electric light was separately conveyed upon each of the pair of pictures by means of a pair of lenses, which strongly illuminated the pictures in a dark room. The stereograph first employed was one of the moon, formerly used in vision by continuous light. The observer placed himself with closed eyes in proper position before the stereoscope, while the manipulator of the apparatus arranged the cards. He was then requested to interpret the combined retinal images produced by illuminating the cards with a single spark, not knowing previously whether to expect convexity, concavity, or flatness, as might be produced by arrangement of the cards and the interval of illumination being too brief for any possible play of the eyes. When the relation between the visual line was such to imply no unusual muscular strain it was found possible to interpret the binocular retinal image correctly by the light of a single spark.

Experiments with other cards were made, all of which tended to confirm the conclusion reached by Helmholtz in opposition to many other physiologists, that neither play of the eyes nor the perception of double images is necessary to the attainment of binocular relief, however important these elements may be in confirming our usual judgments whether conscious or unconscious. To test the illusions of abnormal vision by the light of the electric spark another series of experiments were made in which the optic angle was varied from 3deg. of divergence to 50deg. of convergence of visual lines. The graduated reflecting stereoscope was employed, the manipulator of the apparatus keeping the observer's record of estimates. Eight estimates for each of thirteen values of the combined image of a pair of stereographs of the moon were recorded on examination, and the results were found to be not widely different from those secured by continuous light. The limits of error were much wider, showing that any single judgment under such abnormal conditions has very little value.

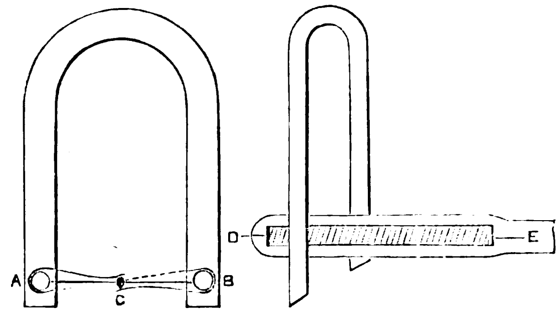
THE DYNAMO-ELECTRIC MACHINE.

The following is the lecture delivered by Professor Rücker during the *conversazione* of the Institution of Mechanical Engineers, held a few days since at Leeds, to which we referred in our Note of last week. Professor Rücker said:—

Mr. Chairman, ladies, and gentlemen,—You have done me the honour of asking me to address you a few words this evening upon a subject which is now exciting great interest both among students of pure science and also among practical men—I mean the dynamo-electric machine. I must, however, start by disavowing any hope that I shall be able to carry out the rather terrible programme which Mr. Davey has laid down for me, viz., to tell you "all about the dynamo." In the short time which alone the exigencies of an occasion such as this place at my disposal it will only be possible for me to mention one or two points connected with it; and as I see before me an audience numbering, I know, amongst its members, gentlemen who are intimately acquainted with the latest developments of technical electricity, and, on the other hand, containing persons who probably have not paid any special attention to the subject, I have to make a choice. I have either to deal with the more advanced or with the more elementary portions of the subject, and I hope I shall do what will, on the whole, please best if I choose the more elementary.

The scientific facts which lie at the basis of the two new industries which are springing up around us, viz., electric lighting and the transmission of power, are very simple. They may be stated as follows:—If in the neighbourhood of a magnet we move a wire which forms part of a conducting circuit, that is to say, a circuit in which an electric current can pass, then as a general rule a current is produced in the wire. If, on the other hand, we keep the wire stationary, and move the magnet, then as a general rule the same result will follow. Either by moving a wire in the neighbourhood of a stationary magnet, or the magnet in the neighbourhood of a stationary wire, a current can be produced. To these facts, which were discovered by Faraday, we owe the whole recent development of electric lighting, and the electric transmission of power. Let us now see how these simple notions have been developed into the complicated machines of to-day, and here I may, perhaps, assist both you and myself if I draw attention to a diagram, which is in the form of a sort of genealogical tree of the dynamo-electric machine. In doing so, however, I must guard myself against misconstruction. This diagram represents the logical, and not the historical, order of the development of the dynamo. It does not profess to decide upon questions of priority of discovery; it certainly does not for a moment hint that the ideas passed through any particular inventor's mind in the particular order in which they are here set down. It is not complete. If it were it would be unwieldy. All that it professes to do—and that I think it does to a certain extent accomplish—is to show how, after the result has been

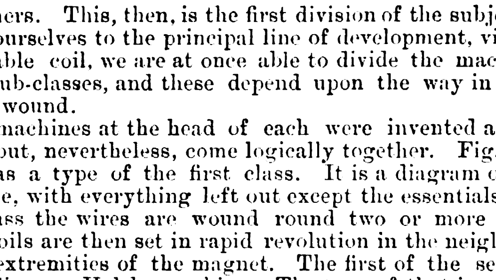
FIG. 1 FIG 2



reached, we may map it out for ourselves, so as to see clearly how some of the principal forms of a machine are logically connected together.

From what I have already said, you will see that there are three ways of producing a current by induction; we may either keep the wire stationary and move the magnet, or we may keep the magnet stationary and move the wire; or we may obtain the same result by moving both, but for the moment I confine myself to the two first cases. Of these, one has been by far the most prolific practically. By far the larger number of inventors have made use of the motion of a wire in the neighbourhood of a stationary magnet rather than of the motion of a magnet in the neighbourhood of a stationary wire. Starting, then, here with Faraday's discovery, we come immediately to the invention of magneto-electric machines, and they may be divided into two chief classes—those in which the magnets are movable and the wire stationary, to which Pixii's, the first constructed, belonged, and the other in which the coils are movable and the magnet is stationary, to which belong Saxton's, Clarke's,

FIG 3



and others. This, then, is the first division of the subject. Confining ourselves to the principal line of development, viz., that of a movable coil, we are at once able to divide the machines into three sub-classes, and these depend upon the way in which the wire is wound.

The machines at the head of each were invented at different dates, but, nevertheless, come logically together. Fig. 1 may be taken as a type of the first class. It is a diagram of Clarke's machine, with everything left out except the essentials. In this first class the wires are wound round two or more coils, and these coils are then set in rapid revolution in the neighbourhood of the extremities of the magnet. The first of the second class is the Siemens-Halske machine. The type of that is represented in Fig. 2. It consists of an iron core round which the wire is wound longitudinally. The core is then set in rotation about its axis between the poles of a magnet. In the third class the wire is wound round a ring, and this kind of machine, of which you see a typical diagram in Fig. 3, was originally due to Pacinotti,

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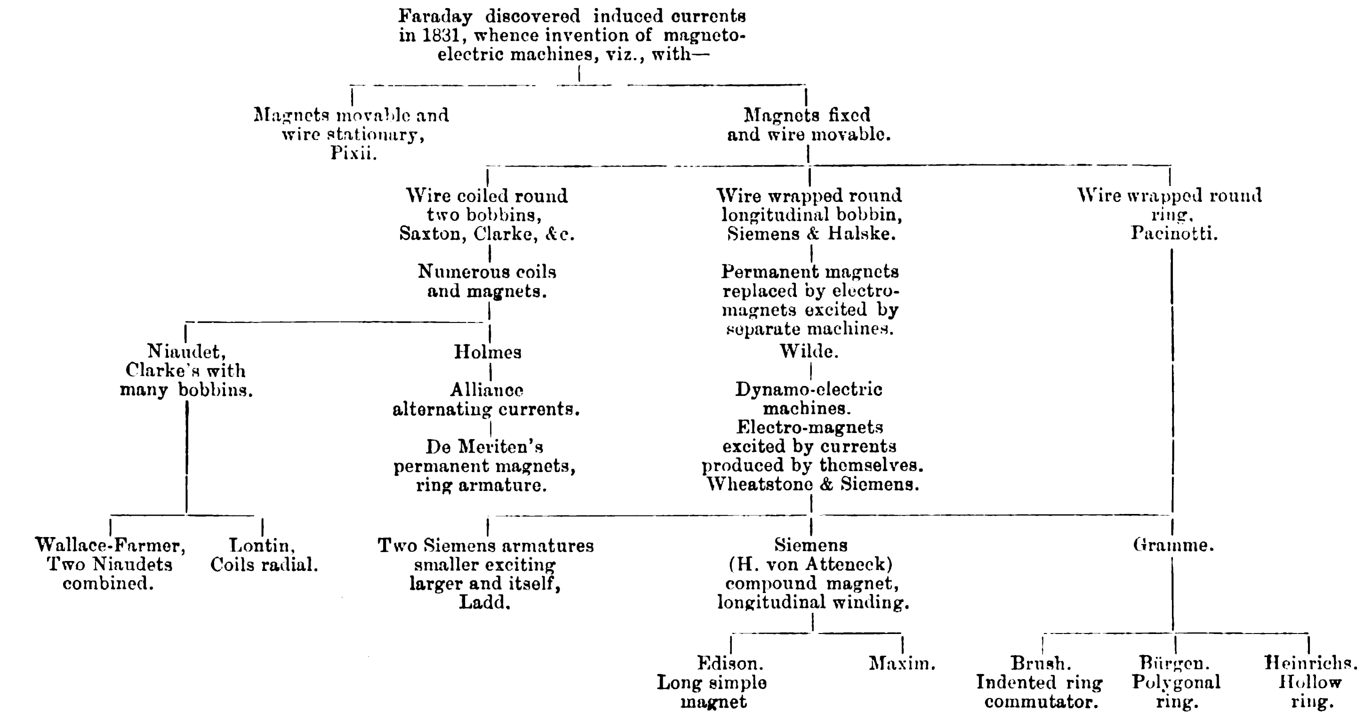
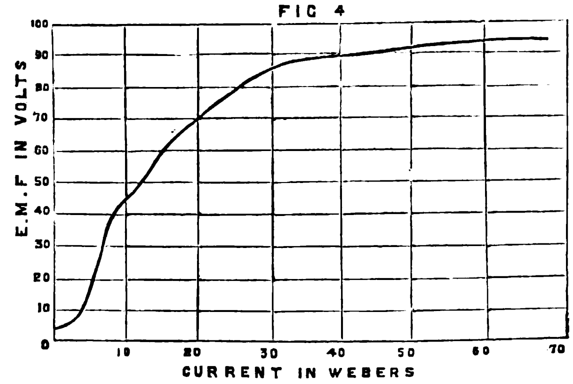


but was first brought prominently before the world by Gramme. Here, then, we have three sub-divisions; the wire wound in coils; the wire wound longitudinally round a single iron core; and the wire wound round a ring. Now, let us follow down the main line of development from the Siemens-Halske machine. The next advance was due to Wilde. His improvement was this. He substituted for the permanent horseshoe magnets which had been previously used an electro-magnet. The machine consists practically of two Siemens-Halske machines. One of them is furnished with permanent magnets, and the current produced by that is used to excite the electro-magnets of the larger machine. They are thus made far more powerful than a permanent magnet would be, and the current produced by the second bobbin is also considerably increased in power. This invention, then, consisted in the supplanting of permanent magnets by an electro-magnet.

The next great step—and this, perhaps, is the most important in the history of the development of the machine—is that which marks the transition from magneto to dynamo-electric machines. Now, as is usual in very great discoveries, this consists of what appears at first sight a comparatively small improvement, and, as is also not very unusual in great discoveries, the idea occurred to several persons at once. The improvement is as follows:—It occurred to Sir Charles Wheatstone and to Dr. Siemens at the same time—their papers was first read on the same day—that it would be possible to do without the smaller machine; and they argued as follows:—A piece of iron which has been magnetised generally retains for a long time a portion of the magnetism which has been given to it. Let us now suppose that, instead of magnetising the iron cores of the electro-magnets in the Wilde machine by passing a current round them, we trust to their own magnetism to begin with, and set the bobbin in rotation, a small current will be produced, because the magnetism will be very weak. But let us so arrange as to pass this current round the wires which excite the electro-magnets. The current will strengthen their magnetism; that will produce in turn a stronger current; that will once more strengthen the magnetism, and the current will again be increased, and thus by the continual process of using the current to strengthen the magnetism and using the magnetism to strengthen the current, we are able to do away with the smaller machine. This process cannot, however, be carried on indefinitely. We cannot increase the magnetisation of iron beyond a certain point, and when this is reached no further increase in the strength of the current will add to the strength of the magnets. This is illustrated by Fig. 4. In it the machine is supposed to be kept revolving at constant speed, and the strength of the current is altered by varying the resistance through which it has to pass. Horizontal lines indicate the current; vertical lines measure the electromotive force, or as the speed is constant they may be taken as measures of the intensity of the magnetisation. At first, you see, as the current increases the latter increases, but after awhile it becomes almost constant.

So far I have carried down the history of the machine to the invention of the dynamo—the machine, namely, in which the electro-magnets are excited by the current which they themselves produce. Here I am afraid I must hurry over my subject more rapidly, both because the differences between the machines become more complicated, and because the time at my disposal will not be sufficient to enable me to deal with them fully. Starting, however, with the dynamo-electric machines, we may divide those which have been invented into two classes, viz., those in which there is a vibrating motion and those in which there is a rotating motion. With regard to the vibrating motion, as far as I know, only one machine has been proposed of this type. This was a machine suggested by Mr. Edison, but which is very different from the one which now goes by his name. Confining ourselves to the rotating motion, the next important advance was the Gramme machine. It is really a development of the Pacinotti machine, to which I have already

FIG 4



referred, and, therefore, I need say little more about it. The essential principle consists in having a revolving ring, round which the wire is wound in a spiral. One of the disadvantages of machines with iron cores round which the wire is wound is that the iron rapidly becomes hot. It is continually being magnetised and demagnetised during the revolution, and this produces heat. A number of other inventors have followed upon Gramme, having among other objects that of diminishing the amount of heat produced in the iron core. The Brush is one of these machines; the Heinrichs is another; the Bürgin is a third.

In the last, in order to prevent the core heating very much, it is made not circular, but polygonal in form; when the wire is wound round it, the angles of the polygon are left bare, so that they are in free contact with the air, and thus it does not get so hot as if it were completely surrounded. This is a type of the kind of improvements that have been suggested. There are, you will see, a number of other machines mentioned which really

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descend directly from the Clarke machine; into their details I need not enter. The improvements which they embody may be briefly described as an increase in the number of magnets and coils, alterations in their relative positions, and the substitution of electro for permanent magnets. The Niaudet, an early form of the Lontin, and the Wallace-Farmer machines, are among them.

Having now, as briefly as I could, sketched before you the development of the dynamo-electric machine, I must pass on to one or two of the uses to which it has been put; and here the particular subject on which I have been asked to say a few words is the transmission of power. Now this transmission of power by a dynamo-electric machine depends upon a principle which is known as the reversibility of the machine. If we make our wire rotate in the neighbourhood of a magnet we obtain, as I have told you, a current passing through it. Now, let us reverse the process, let us keep the wire near the magnet, and instead of moving it, pass a current through it; under those circumstances the wire begins to move. You see, then, that there are these two closely related, but, as it were, opposite facts—the one, that a wire when moved in the neighbourhood of a magnet has a current produced in it; the other, that a wire through which you convey a current in the neighbourhood of a magnet tends to move. I can illustrate both of these facts by some experiments. For the convenient little instruments before me I am indebted to Mr. Cutriss, an electrician in this town, who makes a small but handy and useful motor. The first point which I wish to illustrate is the fact that by turning the wire we can produce a current. To prove that there is a current I shall illuminate some small Swan lamps, which will glow and thus prove a current is passing. [Experiment.] Let us now come to the opposite fact, viz., that a current will produce motion of the wire. I have under the table a single galvanic cell; the current from that I shall pass into one of Mr. Cutriss's motors which is attached to a small ventilating fan. A piece of cardboard is fastened to the axle of the fan to enable you to see its motion. When it is moving you will also see that the stream of air issuing from the fan will blow out a taper at a considerable distance. [Experiment.]

Having, I hope, by these two simple experiments impressed upon you the fact of the reversibility of the dynamo-electric machine, let us for a moment consider how this reversibility can be applied to the transmission of power. By the transmission of power we mean this—the performance of a certain amount of work at one place, and obtaining the equivalent of the whole or a portion of that work at another. We may transmit power in a number of different ways. We may transmit it by means of a rope. If you pull at one end of the rope you can transmit power to the other end. We can transmit power by a belt in machinery. In the transmission of power by electricity we use no rope or belt, but the electric current itself. The transmission is effected in this way. We use one dynamo to produce a current; that current is passed to another dynamo; passing through it, it sets in motion, and that motion can then be utilised to rotate an axle or to set machinery of any kind at work. We have here an experiment illustrating this. Here is a small dynamo connected with a motor. As soon as the wheel of the dynamo is turned, you will see that the motor rotates. Thus we have transmitted the power across the table from one machine to the other. If, however, any mere toy experiments of this kind were all that the transmission of power meant, it is evident that however interesting it might be to scientific men, it would be of little interest or importance practically. But some of our keenest intellects see in the not very far distant future the possibility of this simple experiment being carried out upon a far vaster scale, and of our transmitting the power of our waterfalls, of the tides, and of the winds, from points where it is not wanted to our great centres of industry where it is most urgently needed. There are, no doubt, many practical difficulties which are yet scarcely touched, but when the combined scientific knowledge and mechanical skill of the civilised world is directed to them, they will in all probability give way.

Now, the first and most important question we can ask with regard to the transmission of power is, how much can we transmit? Can we obtain the power which we put into the machine at the other end? If we cannot, how much of it shall we lose? You know that in the steam engine we obtain the work which is done at an enormous expense, that for every ten units of work produced we have to spend an amount of heat which could produce 100 units of work. In other words, we only get one-tenth—in some cases it is rather more, about one-ninth—of the total amount of heat put into the engine expended in work. Now, if there were to be a great additional loss of this kind in transmitting power, it is evident that that would be a very serious defect; but we have a very good hope that the power can be transmitted without any such serious loss. A short time ago a calculation was made by a French savant, M. Deprez, which shows that by means of the expenditure of 16 horse-power we can obtain a return of 10 horse-power at a distance of thirty-one miles by means of an ordinary telegraph wire. Here, then, instead of obtaining one-tenth, we obtain, you see, five-eights of the whole returned to us. Sir William Thomson has also devoted himself to these calculations, and he, too, holds out the hope that vaster sources of energy, such as Niagara, may be turned to use by sending a portion of that energy by the electric current to centres of industry even 300 or 400 miles distant. On the whole it seems reasonable to hope that about 50 per cent. of the amount of work spent in the first dynamo may be utilised at a considerable distance.

With these few remarks I will conclude what I have to say. I have attempted to deal only with a part of the subject. I have endeavoured in this to be as clear as possible, and if I have conveyed to any of you not well acquainted with the subject some notion of how the dynamo works, and how it may transmit power, my object will have been obtained.

PILSEN, JOEL, AND GENERAL ELECTRIC LIGHT COMPANY.

The first ordinary general meeting of this Company was held on Monday at the Cannon-street Hotel, Sir Rawson J. Rawson in the chair.

Mr. E. T. Gregory (the secretary) having read the notice convening the meeting,

The Chairman said: You are aware gentlemen that the present meeting is convened in accordance with the provisions of the Companies' Act, which requires that a general meeting of the shareholders should be held within four months of the registration of the company. That is the first purpose for which we are met, the second is to form ourselves into an extraordinary meeting after the business of the general meeting is finished for the purpose of making certain changes in our Articles of Association, which the Committee of the Stock Exchange consider desirable in the interest of the shareholders. There is therefore little doubt that you will be ready to agree to the proposals of the directors in the extraordinary meeting. Although this is not a meeting at which it is usual to enter into any detailed statement of the proceedings of the Company, which we hope to do at the end of one year, and be able to present to you a very satisfactory report, yet the directors have pleasure in meeting their shareholders, and in giving them information as to the operations of the Company since it was formed. The Company was registered on the 15th May, it was advertised on the next day, and as you may perhaps be aware such was the anxiety of the public to obtain shares in any new electric company at that time, and we hope especially in the Pilsen Company, that on the afternoon of the 16th we were obliged to advertise that no more applications could be received in town after the 17th, and from the country after the 18th, and in fact when we examined our applications we found that for the 28,000 shares which we had to dispose of to the public, we had applications for 108,000; for a capital of £140,000 we had applications amounting to £1,035,000, that is to say, more than seven times the number of shares of which we had to dispose. The allotment was completed on the 23rd of May, and the distribution was to about 800 shareholders. The shares were issued at the value of £5. At first we contemplated to call up £2, and then at a short period another £1, making £3, but the directors have hoped to be able to conduct the business with a capital of £2 a share, which is all that has been called up, and that amount has already been paid, with the exception of a trifling amount of £75 by a shareholder, who happens to be abroad in the United States. The allotment was completed on the 23rd May. The next step was to obtain the legal transfer of the patents from the vendors. Some little delay arose with regard to this, caused by the pre-existing engagements between the vendors and the patentees, which necessitated a certain delay in getting the settlement and quotation for our shares from the Committee of the Stock Exchange. They very properly do not allow companies to obtain that until they are satisfied that all preliminary forms have been completed. The consequence was, it was only on the 5th of July that our Company was formally constituted by the transfer of property from the vendors to the present Pilsen, Joel, and General Electric Lighting Company. From that date we consider we have been constituted, and that we have been at liberty to dispose of the capital of the Company in the manner that we consider most advantageous for the interests of the shareholders. That is only two months ago; our existence is very brief, and the shareholders cannot expect that we should have been enabled to do a great deal in that short period. Other circumstances also have influenced our operations. You are aware that the Company came into existence, I may say, on the crest of the last wave of the public excitement in favour of shares in the electric light companies. Before even our shares were allotted they were in the market, and selling at a considerable premium; but before they were allotted a reaction, as rapid and as sudden as the excitement, had set in, and, consequently, before the Company was actually formed and in operation, it had to take a very different view of its prospects from what it had when it was first created. When it was first created it might have hoped to sell a number of concessions, to form a number of sub-companies, in the same way as its great predecessor and other predecessors, but from the moment of its existence it was pretty clear that the Company must look for its future profits, especially from manufacturing, from establishing a successful and economical manufactory of its valuable patents, from which it would be able to obtain a permanent annual income that would amply reward its shareholders for their investment. And that has been the aim of the Company from the time of its existence. Within a short time after its creation certain concessions were proposed, but, with one or two exceptions, it was quite clear that the parties had no intention of doing business in the

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matter; their sole object was to gain the advantage of the promotion money. We do not like to associate ourselves with companies not likely to be a commercial and financial success, and, therefore, it is not by forming sub-companies that it hopes that when it has shown the excellence of its lights and the advantage to be derived from association with the Company we shall be able to form local associations that will add to the profits and increase the reward of the investors. Well, then, having determined that manufacture was to be our great object, we lost no time in seeking for a suitable factory. We consider that we were fortunate amongst those that presented themselves in obtaining at Kentish Town a set of buildings, for it actually is three separate blocks connected together of the most substantial description, in an excellent situation, with good light, admirably adapted for our particular manufactures, and with which we shall be connected by a telephone. The advantage of this was that we did not wish to burden ourselves with too large an affair until we were satisfied, not only as we ourselves were, of the excellence of our lamps and the profits that may be derived from their manufacture, but that the public should share in that confidence. We were unwilling to burden ourselves with too large an establishment, and we, therefore, engaged this factory for only three years certain, with the power of taking a lease afterwards for seven, fourteen, or twenty-one years, so that if, as we expect, the manufacture will be a success, and a large success, we have the means of continuing there and developing our manufactory. Another advantage of this was that for the first six months we actually paid no rent, so that until we are fairly at work there we are rent free in the factory. A third advantage is that, from its constitution, we can begin modestly in one of the blocks, where we will employ about 200 hands, and can advance as the demand for our lamps increases; and as we gain experience in our manufactory we can advance from this single block, employing 200 hands, into the other block, which I think will employ a similar number, so that we may, before the end of the year, be employing from 400 to 600 hands in the manufactory. At present we may say that we have not been actually employed there much more than eight or ten weeks. We have at present upwards of seventy hands at work, and are only waiting for a larger employment until our own installation is complete, and as soon as all that is complete we shall be enabled to enter fully into the occupation of that part, and to turn out a sufficient number of lamps and dynamo-electric machines amply to repay, from that block alone, the interest on the capital employed. We had the expectation that we should be able to get a supply of machines and Pilsen lamps from abroad sufficient to meet any immediate pressing demands; but it was found that, such was the demand on the factories at Pilsen and Nurenburg for those machines and those lamps, that they could only supply a small order to us, and, therefore, we have been thrown back entirely upon our own manufacture. The question was whether we should employ other parties to manufacture for us. Now, that was well considered by the directors, and there were many reasons why we should at once embark in our own manufacture, and it was for the advantage of the shareholders that we should confine ourselves to our own manufacture. First, the season admitted of a certain amount of delay, because in the middle of summer people were not very anxious to obtain new lamps of this description, and we had every reason to hope, as we have every reason to hope now, that we shall have a supply when the demand is pressing upon us. With regard to our manufacture, we are now manufacturing each of the kinds of manufacture which we are able to offer to the public, and for which we have the patents. We have the full installation of the incandescent light for the Gatehouse light, which, when we were first created, as appeared in our prospectus, was not then perfected. It is now perfected, and very much improved, and we are turning out a sufficient number daily of these lamps to supply our demand. We have a supply of Joel lamps. We have a supply of Pilsen lamps on the point of completion. We have dynamo machines in hand, and we expect that in the month of September we shall have a sufficiency of everything that we offer to the public to supply our customers with. We have also obtained since we were created a patent for a new accumulator, which we believe will turn out a very successful invention. We believe that it will be a success in efficiency, in economy, and in convenience, and as regards price and weight, that it will recommend itself to the public in comparison with any other that exists; and if those expectations are realised, as we feel confident they will be realised, we shall have a perfect system of lighting in our four systems—Pilsen arc, Joel semi-incandescent, Gatehouse incandescent, dynamo machines suitable to all of them, and this accumulator to supply the public in the most efficient manner. With regard to other operations, I may say that we have been limited by the small supply of machines and lamps which we have been able to avail ourselves of. We took over a certain stock from the vendors, who had obtained them from the patentees, and we obtained as many dynamos and lamps as the companies at Pilsen and Nurenburg could supply us with. These we have utilised as far as possible. We have shown them in London, where they have been exhibited at Messrs. Balser's, in Holborn (where, by the by, I may state that we have obtained a site for a depot which promises a demand for lamps in the surrounding building sufficient to offer to the Company a very profitable installation); at Messrs. Crisp's, in the north of London; and at Liverpool, where we have at present agents actively employed in visiting the different large buildings there and obtaining orders for our lamps. Wherever our lamps have been shown they have obtained the highest favour. We believe that in the Pilsen lamp we have the steadiest and the brightest, and the easiest worked, and the safest and most advantageous light. In the same way we are satisfied that in the Joel and Gatehouse lamps we have excellent lamps to offer to our customers, that cannot be surpassed by any other, and we believe we have everything that the public can desire in the shape of electric lighting. I may mention that we are in communication with two of the most important dependencies of the Crown for concessions in them, and, inasmuch as there we shall be able to give the right of manufacture which we cannot give to *concessionnaires* in the United Kingdom, we believe that we shall be able to sell the right of sale and manufacture at great advantage for our shareholders. It will be satisfactory to our shareholders, and I have pleasure in noticing that the Pilsen arc light and the Joel semi-incandescent light obtained the gold medal of the jurors at the Crystal Palace, in the same way as the arc light obtained the gold medal in Paris. There is, therefore, no doubt that the Pilsen light stands possessing the highest testimonials both from the English and French jurors [cheers]. I have very little more to say. Although we have not sought, although we have not thought it necessary or advantageous to spend funds in public exhibitions that do not yield immediate profit, trusting to the excellence of our lights when they are fairly exhibited by sale to the public, we have provided for an exhibition of our light in the Crystal Palace at the coming exhibition of the ensuing winter, and we have also sent our lights to the North-East Coast Exhibition at Tynemouth, where the parties supply us with power, and the expenses of the exhibition there will be very light. In conclusion, I would say that the object of the directors has been to ensure a substantial, profitable manufacture of their several patents, to study strict economy in their arrangements, to avoid all expensive agencies, to abstain from costly and unremunerative exhibitions, and so to conduct the operations of the Company as to realise, as they are confident they will realise, for the shareholders an ample and most satisfactory return for the money invested in the shares of the Company [cheers].

Mr. BLAYDON said with reference to the floating of the Scotch subsidiary company, the prospectus of which was advertised, he took it that they did not suffer any pecuniary loss from the capital of the company not having been taken up. He felt sure that they need not fear as regarded dividends. He thought that they possessed a light which would beat any other light for steadiness and simplicity. He thought it would be very satisfactory if the chairman could inform them that there was nothing in their incandescent light which would bring them within the pale of the proceedings threatened against some other very important companies.

The CHAIRMAN said, in reply to questions, they certainly were not losers by the Scotch company. They had nothing whatever to do with the preliminary arrangements of the company, and therefore the matter simply dropped through. With regard to the Gatehouse lamp, it was really only exhibited at the Crystal Palace towards the end of the exhibition, and at that time it was not actually perfected. In their advertisement they stated that the Gatehouse lamp was not at that time perfected. It had now been perfected, and as far as it had been tried it was an admirable lamp, and was likely to be a very remunerative manufacture.

Mr. BLAYDON: You hope we shall be free from any litigation with regard to the incandescent light? Edison claims it as his own.

The CHAIRMAN replied he supposed they must take their chance. As regarded the appliances by which they gained their incandescent light, they had no fear of any other company claiming the patents. He ought to say that the great advantage of the Gatehouse lamp, as far as they knew it, was its endurance and its vitality, and it was less likely to break than any other lamp with which they were acquainted.

Mr. BLAYDON thought the chairman's explanation very satisfactory.

Mr. F. FELLOWS said they could burn all the lights in a room at one uniform intensity. They had made a number of Joel lamps, and were able to turn out any quantity, and the Pilsen were in process of manufacture. Their object had been to be independent of all outside aid. They might, of course, if there was a great demand, feel it necessary to get outside aid, but they would be perfectly independent, so that they could supply anything wanted by their customers from their own manufactories. He endorsed what had been said about the great value of the accumulator they had secured.

Several special resolutions were then passed, making some formal alterations in the Articles of Association, in order to comply with the rules of the Stock Exchange.

Mr. BLAYDON said he had great pleasure in moving a vote of thanks to the chairman and directors. They might feel a little temporarily discouraged by the fact that they did not get on the top of the wave of prosperity, but they had nothing to fear. He believed they had as perfect a system as possible; it was only a question of time, and he was certain the shareholders would be perfectly satisfied.

The motion was seconded and carried unanimously.

The CHAIRMAN: I have to thank you, gentlemen, and only hope we may be able, in the course of twelve months, to present a very satisfactory report.

The proceedings then terminated.

AUSTRALASIA ELECTRIC LIGHT, POWER, AND STORAGE COMPANY (LIMITED).

The statutory meeting of this Company was held at the office, Copthall-buildings, on Monday, the 11th inst., Mr. Randolph C. Want in the chair.

The notice calling the meeting having been read by the secretary (Mr. J. H. Duncan), the following report of the directors was taken as read:—The directors beg to report that so soon as the Company was formed, and the capital subscribed, endeavours were made to secure an influential representative in Australasia with a view to starting the Company's business there. They consider themselves fortunate in having been able to come to an agreement with Sir Julius Vogel, then about to proceed to Australia, and who is both largely interested in the Company and well known in the Colonies. Sir Julius left England in May, and arrived in Melbourne on the 26th of June. His advices, being so far principally received by telegraph, are necessarily brief, but they are of such a character as to encourage the directors to entertain favourable opinions of the Company's future, and to hope for a satisfactory conclusion to several pending negotiations of considerable importance for electric lighting. The application of the Company for a settlement and quotation upon the Stock Exchange has been granted by the committee, but subject, as to the quotation, to an undertaking on the part of the directors to submit to the shareholders certain verbal alterations in the Articles of Association. These are set out in the notice convening a special meeting immediately after the termination of the ordinary or statutory meeting.

The CHAIRMAN stated that the meeting had been convened that day to comply with the requirements of the statute. He thought it would have been better if they had been enabled to delay the meeting till they had been advised more fully by their representative in the Colonies, but as the law required the shareholders had been called together. He had every reason to feel that the Company had been formed on a sure and satisfac-

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tory foundation, and that its prospects were good. He thought, no doubt, many of the shareholders would have been more pleased to have found that they had effected sales of concessions, the same as the present Company had done, but that was not at present the case. The directors had arranged with Sir Julius Vogel, who had been for many years connected with the Colonies, and was at one time Premier, to represent the Company in Australia, and arrangements were being made with the colonists for the testing of installations, and, subsequently, of disposing of licenses and concessions. They had already contracted to light one town, and he had no doubt this would lead to others. It had also been arranged to light by the Company's system of electric light the railway station at Melbourne. This railway station at Melbourne was very different to our railway stations in this country. For, whereas they had the Cannon-street, Victoria, Charing Cross, &c., to go from to reach any particular place, all passengers leaving Victoria (Melbourne) had to go from that particular station to be lighted by the Company, so that it would be seen that it would be a very profitable advertisement as to the supremacy of the light. According to a telegram received it would appear that they had orders for 10 installations, but as at times messages were not correctly rendered it might be that only two installations was meant, and it was, consequently, thought best to be on the safe side, and he, consequently, did not wish to say much about the quantity of orders. He did, however, wish to convey that the Company's patent was being appreciated in the Colonies, and that, and looking to the fact of their being, practically, the first in the Colonies, it was of great advantage to them. They were somewhat in disgrace with Sir Julius Vogel for not supplying as fast as ordered, but it must be recollected that the demand on the parent Brush Company was so large that difficulty was experienced in getting orders completed. As fast as they could get their dynamos, engines and plant were shipped, and they were now on their way to Melbourne, Sydney, and Western Australia, as well as New Zealand. The larger part were on the sea, but some were in the Colonies before Sir Julius Vogel arrived out, and had been disposed of. The board had arranged for the acquiring of an accumulator stated to be the best yet introduced. It was known as the Sellon-Volckmar, and the Company had paid £5,000 for the option of purchase within a year. It had not yet been purchased, and the Company stood in the position of exercising this right when the accumulator had been clearly proved a success. He had, he believed, given the shareholders as much information as he possibly could at that time, for, as he had previously stated, he would have liked the meeting to have been held later on, but they had met as the Act required, and he had told them what they had been able to do up to the present time. If, however, the shareholders had any questions to ask he would be most happy to reply to them.

Mr. G. JACKMAN said that he did not think that the directors had acted like business men in paying away £5,000 for the right to purchase an accumulator, and that he considerd, as far as what the Company had paid for in Australia, it was paying for a myth.

The CHAIRMAN explained that the shareholders had the prospectus before them when they applied for shares, and it clearly set forth that the vendors are the Brush Electric Light and Power Company of Australasia (Limited), a company privately subscribed to acquire the Brush patents for the above Colonies, who are also the promoters and pay all preliminary expenses of this Company up to allotment. The principal inventions of Mr. Brush have already been patented in Victoria, New South Wales, New Zealand, and South Australia, and those of Mr. Lane-Fox in Victoria and New South Wales. These patents and the right to apply for similar patents in the remaining Australasian colonies, and for patents in respect of the inventions of Mr. Brush for a reflector and a governor, and for certain recent subsidiary inventions of Mr. Lane-Fox, together with all other improvements to which the Anglo-American Brush Light Corporation (Limited) may become entitled under existing agreements with those gentlemen respectively, have been acquired by the vendors to this Company, and will be transferred. Instructions have already been given to the patent agents for application to be made in the remaining Australian colonies and Tasmania and New Zealand for the inventions already patented as above. The £5,000 for the option of procuring the accumulator was considered a very good bargain at the time.

In reply to other questions from Mr. SEELY and other shareholders,

The CHAIRMAN stated that the purchase price of the Sellon-Volckmar patent would be £100,000, the £5,000 being paid for the option of purchase. For India that amount was paid, partly in cash, and partly in shares. If worth purchasing, this Company would obtain a very desirable patent, if not, they would probably lose the £5,000; but he could not say definitely. Indeed, it was impossible to say what would be the fate of the £5,000, and he thought it in the interest of the shareholders not to say anything more about it at present. The place to be lighted in Australia was Perth, the capital of Western Australia. They only heard from Sir Julius Vogel at present by wire, and were awaiting letters, which would give them more detailed and definite information. The lighting of the station at Melbourne the directors regarded as very valuable for the Company. Sir Julius Vogel was well acquainted with the Colonies, having held the position of Premier of New Zealand and the Agent-General of New Zealand. The number of shares applied for was 186,000, whilst they had only 24,000 to allot. It was considered the best plan to start installations themselves. They had the right to the patent for the term of the concession, a period of 14 years.

The CHAIRMAN then called upon the secretary to read the notice calling an extraordinary general meeting to consider, and, if approved, to pass the following resolutions :—1. "That the 69th of the Articles of Association of the Company be amended by striking out the following words at the commencement thereof, namely, 'notwithstanding any rule of law or equity to the contrary.'" 2. "That the 71st of the Articles of Association of the Company be amended by altering the figures '1885' occurring therein to '1884,' and altering the figures '1886' occurring therein to '1885.'"

The CHAIRMAN then moved the first resolution, and in doing so explained that the alterations proposed were to meet the requirements of the Stock Exchange.

This was seconded by Mr. J. J. CATES (director), and agreed to.

The CHAIRMAN stated, in moving the second resolution, that by the 71st Article of Association the directors did not retire before 1885, and it was considered advisable to alter that date to 1886.

The resolution was seconded by Lieut.-General H. MEEDE HAMILTON, C.B., and agreed to.—The usual votes of thanks closed the meeting.

YORKSHIRE (BRUSH) ELECTRIC LIGHTING COMPANY (LIMITED).

The statutory meeting of this Company was held on Thursday, at the Cannon-street Hotel, Mr. H. W. Law in the chair.

Mr. MORTON (the secretary) having read the notice convening the meeting,

The CHAIRMAN explained the formal object of the meeting, but afforded some information as to what the Company had been doing. They had secured the services of a thoroughly experienced electrician, and had opened an office at Leeds in a very central position for the business they expected shortly to be doing. Many applications had been made to the Company, and negotiations were in progress which he hoped would end satisfactorily. The Stock Exchange had not yet granted a quotation, but they were now in correspondence with that body on the subject. He informed the meeting that the Company had one installation of lights at the Bradford Exhibition, and it certainly gave the greatest satisfaction on that occasion. They had also taken some important steps in anticipation of a large business in and about the town of Middlesborough. A plot of ground had been leased on advantageous terms; and a purchase of plant effected for the Brush Company, at a considerable discount—a discount which represented a much larger profit than could have been derived from investing the money as they had contemplated doing.

A vote of thanks to the chairman and directors terminated the proceedings.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Sept. 13.		Business Done Week Ending Sept. 13. Highest.	Lowest
Anglo-American	51,	52	51⅝	50¾
Do. Preferred	82,	83	82⅝	80⅞
Do. Deferred	20,	21	20¾	20¼
Brazil Submarine	11⅝,	12⅛	12	11⅞
Cuba	9¾,	10¼	—	—
Do. Preference	16,	17	—	—
Direct Spanish	6½,	7	—	—
Do. Preference	15½,	16½	16	15⅞
Direct United States Cable	11½,	12	11⅞	11 13-16
Eastern Telegraph	10¾,	11⅛	11¼	11
Do. 6 per Cent. Preference	13,	13¼	13¼	13
Do. 5 per Cent. Debentures, 1899	100,	105	—	—
Eastern Extension	11¼,	11½	11 7-16	11¼
German Union	9¾,	10¼	10	9¾
Globe Telegraph and Trust Company	6⅝,	7	6⅞	6 9-16
Do. Preference	12½,	13	13	12 13-16
Great Northern	12¼,	12¾	—	—
Indo-European	29,	30	—	—
Mediterranean Extension	2,	2⅜	2⅜	2⅜
Do. Preference	8½,	9	—	—
Reuter's	12¾,	13½	13⅛	13⅛
Submarine	255,	265	255	255
West India and Panama	1¾,	2	2 1-16	1⅞
Do. 1st Preference	8¾,	9¼	9	8⅞
Western Brazilian	7,	7½	7¼	6 15-16
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1,	1¼	1⅛	1 3-16
Oriental	¾,	1	1	13-16
United Telephone	10,	10½	10⅝	10⅛

ELECTRIC LIGHT.

Maxim-Weston	⅜,	⅝	½	7-16
Anglo-American Brush	11¾,	12¼	12	10⅞
Eastern Electric	2¼,	2½	2½	2¼

TRAFFIC RECEIPTS FOR AUGUST, 1882.

Companies.	Aug., 1882.	Aug., 1881.	Incrse.	Decrse.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,550	2,401	49	—
Direct Spanish Telegraph Company	1,790	1,507	283	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	32,025	30,349	1,676	—
Eastern Telegraph Company	51,600	38,171	13,429	—
Great Northern Telegraph Company	23,360	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	3,400	3,185	215	—
Western and Brazilian Telegraph Company	—	—	—	—

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

3711. IMPROVEMENTS IN ELECTRIC LAMPS, *F. H. F. Engel, Hamburg.—25th August*, 1881. —(*A communication from C. H. F. Müller, Hamburg.*)—(*Not proceeded with.*) 2*d.*

This consists in the use of sheet platinum in strips of about ¼in. wide, to connect the conductors with the carbons in incandescent lamps, instead of the wires hitherto employed, the sheet strips being more easily fixed into the glass globes.

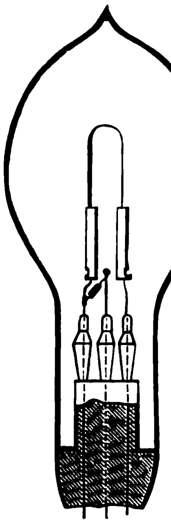
3731. IMPROVEMENTS IN APPARATUS FOR TRANSMITTING AND RECEIVING AUDIBLE SIGNALS BY MEANS OF ELECTRICITY, *A. F. St. George, London.—26th August*, 1881.—(*Not proceeded with.*) 4*d.*

This invention relates to apparatus used for the purpose of acoustical telegraphy or telephony, and a cheap and new method of constructing such apparatus, and consists in two coils of iron or steel wire, through one of which a constant current from a battery is flowing, and the other of which is connected with a vibrating diaphragm.

3890. ELECTRIC LAMPS, *D. G. Fitz-Gerald, Brixton.—8th September*, 1881. 6d.

Unsized paper or any suitable vegetable fibre is treated with a concentrated solution of zinc chloride to be formed into parchment and then carbonised whilst protected from the air. Special

3890



care is taken, and claims are made for the method of connecting the filament to the conducting wire. In order to obtain a globe perfectly free from oxygen, the oxygen remaining after exhaustion is extracted by oxidising a strip of magnesium ribbon. The figure shows a section of the finished lamp.

3944. IMPROVEMENTS IN TELEPHONES, IN PART APPLICABLE TO OTHER ELECTRIC APPARATUS, *W. E. Irish, Sunderland.—12th September*, 1881. 6*d.*

The improvement consists in winding the wire in continuous convolutions around both poles of the magnet and the intervening space as though there were but one pole, so that when a current is sent both poles are utilised for reproducing the sounds transmitted. The inventor also uses two diaphragms, one in the usual position and the other at the opposite end of the magnet, that is, between it and the part of the case to which it is secured.

4005. STORING ELECTRICITY, *J. S. Sellon, London.—16th September*, 1881.—(*Not proceeded with.*) 2d.

Sheets, foil, gauze, or any form of suitable material have deposited on them suitable metallic salts.

4060. REGULATING THE DISCHARGE OF SECONDARY BATTERIES, &c., *A. M. Clark, London, 20th September*, 1881.—(*A communication from N. de Kabath, Paris.*) 6*d.*

The discharge is regulated by varying the resistances, such as varying the height of the liquid in the battery.

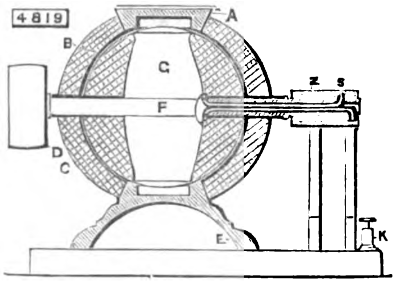
4310. SECONDARY BATTERIES, *A. P. Laurie, Edinburgh.—4th October*, 1881. 4d.

Copper plates are immersed in a solution of chloride of zinc, the essential feature being the storing of chlorine for use as a source of electricity by combining it with the copper to form cuprous chloride.

4819. MOTORS ACTUATED BY ELECTICITY, *W. L. Wise, Westminster.—(A communication from E. Bürgin, Basel, Switzerland.)—3rd November*, 1881. 6d.

A is a hollow sphere of thin brass or other non-magnetic metal divided into the hemispheres B and C. These latter, B and C, are wound with insulated wire D in convolutions parallel to the horizontal plane of the junction. The pedestal E

4819



is formed in one with C. On the shaft F is an iron core, C, wound with insulated wire, till it is rather less than interior of sphere A. The other parts of the machine are clearly shown. The current enters at K, traverses the coils H to S, then by brush to outer conductor, and through Z and a brush to a second terminal.

4825. REGULATING DYNAMO-ELECTRIC MACHINES, *C. A. Carus-Wilson, London.—3rd November*, 1881. 6d.

The current is used to act on the governor of the steam engine.

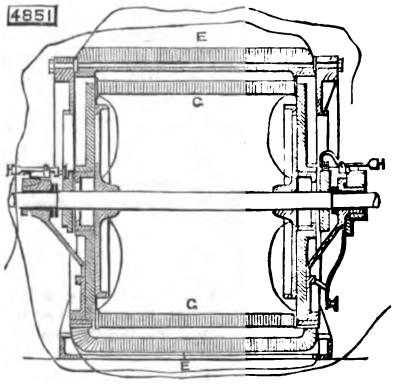
4850. IMPROVEMENTS IN THE MANUFACTURE OF CARBON TO BE EMPLOYED FOR THE PRODUCTION OF ELECTRIC LIGHT, *C. J. Allport, London, and R. Punshon, Brighton.—5th November*, 1881. 2*d.*

The inventors immerse a thread of asbestos in a saturated solution of sugar or other saccharine matter, and carbonise the same by dipping the thread into a hydrocarbon and setting fire to it. This is the method of preparing carbons for incandescent lamps; for arc lights the asbestos is so disposed as to serve as a binding agent to prevent large pieces of carbon from breaking off.

4851. ELECTROMOTIVE ENGINE, *D. T. Piot, London.—5th November*, 1881. 8d.

The figure shows a longitudinal section, by means of which the arrangement of field magnets

4851



E and armature coils G will be seen. The inventor has these crank-shaped cores wound circularly with insulated wire, also the arrangement adopted.

4854. IMPROVED MEANS AND APPARATUS OR APPLIANCES CONNECTED WITH THE PRODUCTION, THE STORAGE, AND UTILISATION OF ELECTRICITY FOR LIGHTING OR POWER PURPOSES, *J. B. Rogers, London.—5th November*, 1881.—(*Not proceeded with.*) 2*d.*

This relates to the production of electricity by means of a dynamo driven by the axle of the engine or any carriage of a train, which electricity is stored in receivers of special construction, and subsequently used to feed incandescent or other electric lamps.

4454. IMPROVEMENTS IN INSTRUMENTS FOR MEASURING ELECTRIC CURRENTS, PARTLY APPLICABLE TO THERMOMETRIC REGULATORS, *J. T. Sprague, Birmingham.—12th October*, 1881. 6*d.*

This refers to improvements on the inventor's patent No. 4762 (1878). First, as regards the galvanometer therein described, in which the needles were of soft iron magnetised by the current itself. The inventor now obtains a more perfect magnetism in the needles by employing a part of the current for magnetising purposes, and the rest as usual for deflection. The invention also refers to improvements on the inventor's instrument for registering the quantity of currents which have passed, consisting of an electro-depositing cell with reversing commutator and a record apparatus actuated by the weight of metal transferred by the current. The improvement consists in the use of a moving electrode, the weight of which is supported by flotation, so that it may rise and sink in the liquid by the change of specific gravity due to the deposit or removal of metal. The electrode is made hollow or provided with floats and fitted with a stem, so that the normal weight of the electrode just immerses the lower part of the stem, while the immersion of the stem just equipoises the metal as added. Various other methods of carrying out the invention are described and illustrated, together with reversing commutators, shunts adjusted to vary in resistance as the meter circuit varies, and a heater and thermo-regulator for controlling the temperature.

4905. IMPROVEMENTS IN APPARATUS FOR THE TRANSMISSION AND RECEPTION OF SOUNDS, *W. C. Barney, London.—9th November*, 1881. 8d.

Fig. 1 shows one form of the inventor's microphone; pencils, P, of hard coke carbon are held loosely by their ends in carbon blocks, B, the other ends being held in a central carbon block,

4905

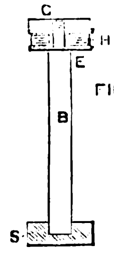


FIG 2.

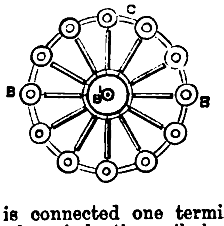


FIG 1.

B^1, to which is connected one terminal of the primary wire of an induction coil about 1in. diameter and ¼in. thick. The outer blocks are connected together by a conductor, C, which is connected to one pole of a battery, the other pole being connected to the other terminal of the primary wire of the coil. Fig. 2 shows one form of the inventor's telephone. A bar, B, of iron, which may or may not be a permanent magnet, has one end fastened to a shoe, S, of soft iron, equal to about five times the weight of E, a soft iron elongation at the other end, on which is placed the helix H. To the end of E is fixed a spiral spring, G, of iron, the end of which may be capped with an iron disc.

4448. IMPROVEMENTS IN ELECTRO-MAGNETS FOR TELEPHONIC AND OTHER PURPOSES, *J. Imray, London.—12th October*, 1881.—*A communication from J. M. Stearns, jun., Brooklyn New York.*) 6*d.*

This invention relates to the construction and adjustment of the astatic cores of electro-magnets in such a manner that their armatures are attracted, whatever be the direction of the currents through their coils. When no adjustment is required for the astatic core, it consists of a simple bar magnet bent at its middle so as to bring its two opposite poles nearly together. These are then near their extremities enclosed within a coil of insulated wire; currents of either direction will then attract an armature presented to the poles. The inventor claims the above as applied to telephonic purposes.

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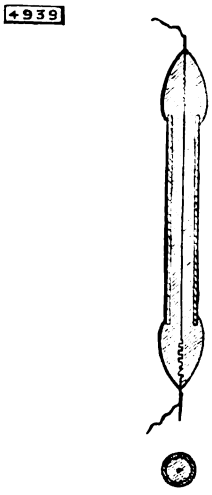
4632. Improvements in the Construction of Secondary Batteries, *J. S. Sellon, London.—22nd October,* 1881.—*(Not proceeded with.)* 2*d*.

This relates to a method of constructing secondary batteries by the use of peroxide of lead, or other metallic oxide, packed upon or round pieces of metal, such metal being used in the form of gauze, perforated or corrugated, and fixed to frames of wood; sheets of a porous material are then packed around the oxides. Thin sheets of lead are attached to one or both sides of the element.

4939. Apparatus for Producing Light by Means of Electricity, *A. F. St. George, London.—11th November,* 1881. 6d.

This is an electric lamp where its filament is



embedded in its transparent envelope, as shown in the figure.

4695. Improvements in the Method of and Means for Utilising Electric Circuits for Various Purposes, such as Telephonic or Telegraphic Communication, or Synchronising Time Measures, &c., *W. F. Barrett, Monkstown, Dublin.—27th October,* 1881. 8*d*.

This invention relates to a method whereby a telegraph or telephone line may be used to keep clocks in unison, give notice of fires, &c. The inventor makes use of Ritchie's or other system of periodic time control from a central station, and adapts to the controlling and controlled clocks electric contacts, which the clock automatically closes and opens at certain times. During the day the controlling and controlled clocks each complete the circuit leading from the line wire to the telephonic or other apparatus, except for a short period, say, ten or thirty seconds, when the circuit is broken by the clockwork, and by the same means the line placed in the clock controlling circuit. The normal clock is allowed then to regulate the controlled clock, and after a few seconds the line is again thrown into the previous telephone circuit. At night the line can be connected to fire or burglar alarms in this way, or utilised in other ways described in the specification.

4748. Improvements in Galvanic or Electric Batteries, *W. R. Lake, London.—29th October,* 1881.—*(A communication from J. F. Aymonnet, Grignon, France.)* 6*d*.

This consists of one fluid battery. The negative plate is of iron or other metal; the positive of charcoal, coke, or the like. The liquid in which they are immersed is a mixture of two aqueous solutions, one of which contains either chlorine, hydrochloric acid, a chloride, or a mixture of these; the other nitric acid, a nitrate, chromic acid, a chromate, &c., or a mixture of them. The cells may be connected by syphons. The inventor states that the electromotive force of this battery is nearly as great as that of a Bunsen, and its resistance less.

4778. Improvements in Incandescent Electric Lamps, *F. Wright, London.—1st November,* 1881.—*(Not proceeded with.)* 2*d*.

This relates to the construction of an incandescent lamp. The carbon is enclosed in a glass globe, with elongated neck, which is flattened where the connecting wires, of platinum, pass through it. The carbon is connected to these by copper wires and very small pieces of platinum wires next to the carbon. A small glass tube is provided for exhausting by.

4758. Improvements in Apparatus for the Transmission of Vocal and other Sounds, *F. J. Smith, Taunton.—31st October,* 1881.—*(Not proceeded with.)* 4*d*.

For transmitting musical or vocal sounds the inventor uses a rectangular box of wood with holes cut in its sides, and pine wood sounding boards attached to two or more sides for carrying the carbon conductors. Sounds coming in any direction will thus strike some one of the sound boards, and cause vibration of the carbon. In transmitters for talking uses the inventor employs carbon rods that have not been shouldered down. Each of these is carried in a cell fixed in a frame. The more carbon rods employed the better the transmission.

4775. Improvements in Electric Lamp, *H. A. Bonneville, Paris and London.—1st November,* 1881. *(A communication from L. Daft, New York.)* 4*d*.

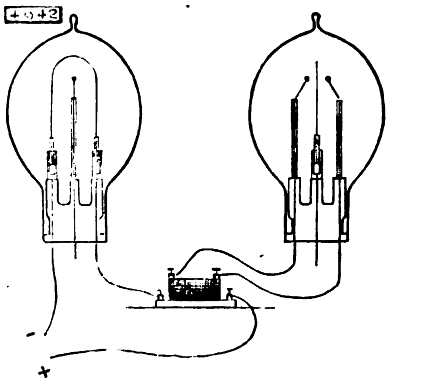
This consists in improvements in arc lamps, in which the upper carbon is regulated by being held in a tubular rod which is attached to the core of an electro-magnet by clips of platinum or porcelain. The carbon descends by gravity. The lower carbon is sustained in a tube containing mercury, which tends to force it up as it is consumed. This carbon is also supplied with regulating or detaining clips. The inventor also claims means for hanging lamps by elastic metallic suspension devices which also form part of the circuit of the lamp.

4777. Electric Lamps, *E. R. Prentice, Stowmarket.—1st November,* 1881.—*(Not proceeded with.)* 2*d*.

The regulation of the carbon was to be effected by fluid pressure.

4942. Applying Electric Currents in the Production of Light, *S. Pitt, Sutton.—11th November,* 1881.—*(A communication from L. Goulard and J. D. Gibbs, Paris.)* 6*d*.

This lamp is a mixed lamp—that is, partly incandescent and partly arc. A carbon thread to



be rendered incandescent is supplemented by two insulated platinum conductors terminating in spheres and connected to a Rhumkorf coil.

4866. Improvements in Voltaic or Galvanic Batteries, *T. Coad, Finsbury.—7th November,* 1881. 6*d*.

This relates to a battery in which the carbon electrode is formed of a number of carbon plates separated by pieces of carbon, the whole being connected by carbon bolts and nuts. This gives greater surface for the negative electrode. The inner or porous cell is provided with a discharge spout, as also is the outer one. The porous cell is hermetically sealed, and the space between it and the outer cell is closed by a removable cover fitting liquid-tight. Each cell is provided with an opening and stopper fo charging.

4867. A New or Improved Cabinet for Voltaic or Galvanic Batteries, *T. Coad, Finsbury.—7th November,* 1881. 6*d*.

This invention relates to a cabinet for holding batteries, provided with doors at the ends, as well as front and back, so as to facilitate inspection of the cells; the latter are fitted on to slides working in grooves, and provided with hinged frames, so that a cell can be slid out and turned over so as to drain its liquid away if required. The specification is accompanied by drawings of the cabinet.

4882. Electric Timepieces, *W. P. Thompson, Liverpool.—8th November,* 1881.—*(A communication from A. Lemoine, Paris).* 8*d*.

The working parts are said to be reduced to a minimum, and the hours struck by electrical mechanism, as is also the regulations.

4812. Improvements in Apparatus for Using Electric Lamps in Locomotives and other Vehicles, *H. J. Haddan, Kensington.—3rd November,* 1881.—*(A communication from W. de Busscher, Brussels.)—(Not proceeded with.)* 2*d*.

This invention consists of an electric lamp placed in front of the engine with a movable reflector, the current for which is generated by a dynamo machine driven from one of the axles of the engine wheels, by a belt and friction wheels.

5028. Telephone Receivers, *R. and M. Theiler, London.—16th November,* 1881. 6d.

The lateral vibrations of the cores of the electro-magnets are communicated as shown in

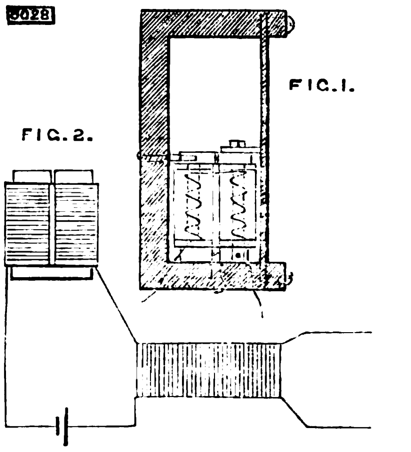


Fig. 1 to a diaphragm or diaphragms. A local battery is used to excite the electro-magnet on long wires, as in Fig. 2.

4855. Improvements in Electric Lamps, *J. B. Rogers, London.—5th November,* 1881. 6*d*.

This relates to a form of arc or incandescent lamp constructed as follows:—The lower carbon is hollow and of large section, the centre being filled with asbestos. The upper carbon can, it is claimed, be adjusted to touch the upper edge of the lower one, and so produce an incandescent light, or made to rest in the centre of the lower carbon on the asbestos, when an arc is formed. The inventor also claims a method of automatically making and breaking connection with lamps fixed on a chandelier or bracket, also methods of employing two or more carbons abutting on a single one to produce an arc light.

4883. A New or Improved Electro-Pneumatic Apparatus for Winding and Regulating Clocks, *M. Bauer, Paris.—8th November,* 1881.—*(A communication from C. A. Mayrhofer and W. Otto, Paris.)* 8*d*.

This invention consists of the combination of a central clock and an electric distributor, which at certain intervals, regulated by the central clock, sends out into electric conductors in various directions electric currents of short duration; also an electro-pneumatic relay for receiving the current arriving from the central clock, which relay sets in motion a pneumatic apparatus in accordance with the electrical impulses received; also a group normal clock, as the inventor terms it, which is kept in corresponding time with the central clock by the pneumatic apparatus; also a three-way air cock, opened and shut by the last-mentioned clock; and, finally, ordinary clocks which are wound up and regulated by the compressed air immediately the three-way cock opens. The above apparatus are combined to carry out the invention, and may be used with ordinary telephone, telegraph, or other conductors, without interfering with their services in other ways. The specification is accompanied by detailed illustrations.

4885. Insulation of Wires, *W. C. Johnson and S. E. Phillips, Charlton.—8th November,* 1881.—*(Not proceeded with.)* 2*d*.

The wires of the cable were each wound with tape which had been dipped in insulating materials, and the whole enclosed in lead.

5002. Improvements Applicable to Dynamo-Electric Circuits, *S. Vyle, Middlesbrough.—19th November,* 1881.—*(Not proceeded with.)* 2*d*.

This relates to a method of dispensing with the return wire to the dynamo, and connecting instead to specially prepared earths.

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Aden.—The Post Office notify that telegrams for Aden cannot be accepted in code or cypher.

Dividend.—The American Bell Telephone Company, of New York, have declared a quarterly dividend of 3 per cent.

Electric Light in Berlin.—It is said that the first trial of the electric lights in Leipzig-street, Berlin, has been a complete success.

Brazilian Submarine Telegraph Company.—The traffic receipts of this company for the week ended September 15 amounted to £3,308.

Electric Light in New Zealand.—News from this colony says that the Kaiapoi woollen factory were about to use the electric light.

The Telephone in Plymouth.—A telephone exchange is about to be opened here by the United Telephone Company, under the superintendence of Mr. H. C. Graham.

The Tyrol.—Telegrams from Vienna state that great floods have taken place in the Tyrol, and that telegraphic communication is entirely interrupted in many districts.

The Eastern Telegraph Company.—The traffic receipts of this company for the month of August, 1882, amounted to £50,868, and to £42,797 in the corresponding period of 1881.

South African Telegraphs.—The revenue receipts of Cape Colony from telegraphs during July last was £5,205, against £5,359 in the same month of 1881, or a decrease of £154.

The Czar's Journey.—During the journey of the Czar from St. Petersburg to Moscow on the 19th and 20th inst. all private telegraphic service in the direction of the latter city was suspended.

Telegraph Conference at Barbadoes.—The *Colonies and India* says that the motion to adopt the suggestions of the recent Telegraphic Conference held here was negatived on division by the House of Assembly.

New Electric Light Company.—The North Eastern Electric Light and Power Company has been formed in Sunderland, with a capital of £100,000, in 20,000 shares. The offices are at 61, John-street, Sunderland.

Edison Light in Ironworks.—An American contemporary states that the Pottstown (Pa.) Iron Company are preparing to light their works, inside and out, by electricity, the Edison lights being selected for the purpose.

New Atlantic Cable.—News from Lisbon states that a contract has been signed between the Portuguese Government and Mr. Braam for the laying down of a cable between Lisbon and the United States, touching at the Azores.

Western Brazilian Telegraph Company.—The traffic receipts of this company for the week ending September 15 were £2,161, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

Crystal Palace Exhibition.—The amount subscribed by gas companies towards the expenses of the special committee of the Gas Institute in connection with the forthcoming exhibition at the Crystal Palace now reaches £3,938.

London Platino Brazilian Telegraph Company.—The revenue of this company for the month of June, 1882, is estimated at £1,934 (Western Brazilian portion £923, land lines £1,011), as against £1,880 for the corresponding period of 1881.

Tenders Wanted for Electric Lighting.—The lighting inspectors of Brentwood, Essex, are inviting tenders for lighting their district by means of electricity. Further particulars can be had of Messrs. Wilson and Whitworth, *Essex Times* Office, Brentwood.

Lighting the Thames Embankment.—The number of electric lights on the Thames Embankment is shortly to be considerably increased, the Metropolitan Board of Works having extended their contract with the Jablochkoff Electric Light Company for that purpose.

Eastern Extension Telegraph Company.—This company notify that they have declared an interim dividend for the quarter ended June 30 of 2s. 6d. per share, or at the rate of 5 per cent. per annum, together with a bonus of 1s. per share, both free of income-tax, payable on the 14th of October next.

Electric Exhibition at Munich. -This exhibition was formally opened on Saturday last, Sept. 16, by Duke Charles Theodore of Bavaria, representing the King. After Professor von Beetz had delivered a speech, welcoming his Royal Highness, to which the latter replied, an inspection was made of the exhibition.

Electric Light in Brussels.—Trials have been made in the periodical room of the Royal Library at Brussels with the Jaspar Electric Lamp. The light is thrown on to a reflector, by which it is diffused throughout the room. A special committee has been appointed to report on the means of lighting the room.

Electric Light and Telegraph Wires.—News from Bombay states that the Electric Light and Power Company having placed their wires at a short distance from the Government telegraph wires, the local authorities have been ordered to remove them. A Government resolution notifies that overhead wires cannot be allowed in any case.

Edison v. Swan.—At the meeting of the Swan United Electric Light Company held this week, the chairman stated with reference to the threatened litigation between Edison's Company and theirs, that there could be no doubt as to the separate character of the inventions, and that he thought it not unlikely that the companies would join forces rather than fight each other.

University College, Bristol.—New buildings are being added to this college, and will be completed shortly, thus affording extra facilities for students. Arrangements have been made by which those who may desire to do so can receive thorough training as electrical engineers, and instruction in electrical science generally. Professor Sylvanus Thompson, so well known in the electrical world, is the lecturer in this branch of science.

Deservedly Punished.—A boy named Hugh Bradley, of Glasgow, was the other day ordered to pay a fine of 21s., or go to gaol for ten days, for maliciously tampering with a street fire alarm in that city. The local paper which records the fact remarks that the offence is a "somewhat frequent one." We think that Hugh Bradley may congratulate himself on having got off very lightly; such practical jokers as he want a judicious admixture of birch combined with their prison fare.

Bleaching.—Messrs. J. J. Dobbie and J. Hutcheson have discovered a method of bleaching by electricity. It consists in passing the stuff to be bleached through sea water between two rows of carbon rollers, the upper row of which is connected to one pole of a battery, and the lower row to the other. The rollers are rotated slowly, and so pass the stuff through the bath. Hypochlorite is formed, and by subse-

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quent immersion in dilute hydrochloric acid the stuff is fully bleached.

Egyptian Telegraphs.—The Eastern Telegraph Company notifies that, in consequence of the land lines between Port Said and Cairo being blocked with Government traffic, the Egyptian Government is obliged momentarily to exclude private telegrams, which can, therefore, only be taken for Cairo at sender's risk. The blo.k of messages at Cairo is at present so great that many are three to four days late. The Eastern Company expects that its own wires to Cairo and Suez will very shortly be restored.

New Factory.—Messrs. Phillips Bros., well known as manufacturers of all classes of electrical apparatus, have, we understand, taken a large factory on the River Lea to meet the increased demand for electric lighting fittings, &c. The factory is to be principally devoted to the manufacture of wires for electric lighting purposes. It will be lighted throughout by the Edison system. We are informed that Messrs. Phillips Bros. are so satisfied with the working of this system in their Homerton factory that they are about to increase the number of lamps in use there by sixty.

Legal.—We have received a cablegram from the Edison Electric Light Company, in New York, informing us that there is no foundation for the statement contained in a Note in our issue of the 9th instant, that a suit has been brought by the United States Electric Lighting Company, of New York, and others against the Edison Company, to maintain the priority of the claim of W. K. Freeman to the invention of an incandescent lamp. We made this statement on the authority of the New York papers, and regret that we should unwittingly have been misled by them.

The Telephone in Cornwall.—At the recent Polytechnic exhibition at Falmouth, a telephone line was specially erected between the Polytechnic Hall and the Drill Hall, about half-a-mile away, and visitors to the exhibition were thus enabled to hold communication with one another. The line was erected by the United Telephone Company, who also showed various telephones at the exhibition, which were the object of much curiosity on the part of the visitors. We hear that three special wires have already been erected in Penzance for telephonic communication, and that more are ordered.

The Electric Railway in Switzerland.—According to further particulars with reference to the proposed electric railway on the Edison system, which a London syndicate is to lay down between Geneva and Ferney, and Geneva and St. Julien, one of these two roads is to be three miles long, and the other from seven to ten miles. They will be used only for passenger traffic. Edison is now building several electric locomotives, but it will be fully three months before they will be ready to be shipped. The constructing engineer of the St. Gothard Tunnel will be employed for the proposed Swiss electric roads.

Electric Light at Bishop Auckland.—During the local Agricultural Show recently held at Bishop Auckland (Durham) a Weston arc light was exhibited by Messrs. Duff and Rowntree outside their premises in that town, the light from which was much admired. Indeed, we are assured that the admiration bestowed upon it was not at all relished by the local gas interests, who would be glad to see the last of it. The lamp was supplied by the Maxim-Weston Electric Company. We believe that Messrs. Duff and Rowntree are making arrangements to have the whole of their sale rooms lighted by means of electricity.

The Telephone in Newcastle-on-Tyne.—The Post Office authorities are extending the telephone system in this quarter, says the *Newcastle Daily Chronicle*, and a new line of pipes has within the past few days been laid from the Newcastle Post Office to the High Level Bridge. The pipes have not been placed along the bridge yet, but a continuation of laying has been resumed at the Gateshead end of the bridge, where the line has been carried up West-street and down Jackson-street. The pipes will extend several miles in length, and the necessary connections for business purposes will be made in a short time.

The 1869 Cable.—We are informed by the Anglo-American Telegraph Company (Limited) that the Telegraph Construction and Maintenance Company, with their s.s. "Scotia," have succeeded in picking up the Anglo-American Company's cable laid in 1869, between Brest and St. Pierre, in mid-ocean, in depths varying from 1,600 to 1,930 fathoms of water, and repairing the fault which occurred on the 18th March last. They have also repaired a minor fault at a distance of 335 miles from Brest, in a depth of 1,269 fathoms. The whole of the company's system of cables and land lines is now in perfect working order and condition.

Electric Light in Antwerp.—*L'Ingénieur Conseil* announces that the company holding the Belgian patents for the Lampe-Soleil have established a central station in Antwerp. It is situate close to the railway station, and comprises a 10 horse-power engine, driving a Gramme machine (separately excited), which supplies current to two circuits of six lamps each. One of these is placed in the first-class waiting room of the station, six in a neighbouring café, four in another café, and one in the machine room. The lighting has been so much appreciated, says our contemporary, that the company have already received orders for sixty more lamps from people in the neighbourhood.

Eastern Telegraph Company.—The Eastern Telegraph Company announce the payment on the 13th October next of a dividend of 3s. per share on the 6 per cent. preference shares of the company, less income-tax, for the quarter ended the 30th inst., and that an interim dividend of 2s. 6d. per share on the ordinary shares will be paid on the same date in respect of profits for the quarter ended the 30th June. The register of transfers will be closed from the 6th to the 13th October. The half-yearly interest on the 6 per cent. debentures will be paid on the 16th October at Messrs. Glyn, Mills, Currie, and Co., 67, Lombard-street, E.C. Coupons should be left three clear days for examination.

Electric Light Wires in New York.—The report of the Superintendent of the Fire Alarm Telegraph of New York concerning the interference of electric light wires with those of the fire alarm system, which was submitted to the Fire Commissioners some two months ago, has at last been acted on, says the *Sanitary Engineer*, and a draft of an ordinance sent to the aldermen for action, providing that hereafter all electric light wires be placed underground and those now in use above ground be strung at least four feet below the fire alarm wires. The report cited a number of instances where considerable damage had been done to fire alarm boxes and slight fires started by contact with the electric light wires.

Electric Lighting in Manchester (U.S.A.).—Electric lights have recently been introduced into Manchester, N. H. The power is taken from a 400 horse-power water wheel, which is rented from the Amoskeag Manufacturing Company, and carried by a 4-in. shaft 400ft. to where the dynamos are located. The counter shaft runs at a speed of 510 revolutions per minute, and is fitted direct to the machine, a friction pulley being used to throw out the counter when necessary. The plant at present consists, ac-

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cording to *Engineering News*, of six 10-light Weston machines, and the circuit is four miles long. There are 30 lights already running on three machines coupled together, giving great satisfaction. Mr. N. W. Ellis is engineer and superintendent.

Electric Light in Liege.—M. Jaspar lately illuminated the Trink-Hall, in Liege, Belgium, by means of one of his regulator lamps fixed at the top of a pole 18 metres high, the pole being lowered when it was required to attend to the lamp. The current was supplied by a Gramme machine, driven by a hydraulic motor, working under a pressure of five atmospheres. This motor, devised by M. Jaspar, gives three horse-power with a consumption of 18 cubic metres, at a pressure of five atmospheres. The cost of lighting the Trink-Hall was defrayed out of the city funds, and amounted to half-a-franc per hour, the water being supplied free of cost. The hydraulic motor was furnished with one of Beer's regulators, and its speed is reported to have been very regular, the lamp working well for two months.

Electric Light in Mills.—The mill of M. Hauzeur, at Val-Benoit, near Liege, in Belgium, has been lighted by means of Maxim incandescent lamps, 64 being used altogether. Thirty-two of these are supplied with current by an ordinary Gramme machine, driven by an engine on the premises, making 1,600 revolutions per minute without overheating. A rheostat commutator allows of any of these lamps being cut out of circuit, or of the whole of the current being sent through all or only a few of a second lot of 32 lamps placed in other parts of the mill, and which are never required at the same time as the first lot. The lamps and plant were erected by M. Jaspar, of Liege, and are reported to have worked to the entire satisfaction of M. Hauzeur for the past three or four months.

Burglaries.—We have heard a great deal lately about what this and that householder would do if he found a burglar in his house. Awful threats have been levelled at the burglarine race generally, and what with these and the gratuitous disclosure of the fortified condition in which certain houses are to be found after dark, we wonder that burglars have any spirit left to continue their—well, vocation. It may be useful, however, to suggest that a few yards of wire, a battery, and electric bell, will provide a very efficient safeguard against these pests of society, and, as the law seems to lean rather to the side of a wounded burglar than to the injured householder, perhaps in this case prevention is better than pistols. Now that electric alarms are to be had so cheaply and easily, we think that those who will not use them almost deserve to be robbed.

A Muddle.—Our American contemporaries are amusing themselves and their readers by publishing an illustration of the appearance of the streets of New York a short distance below the surface. The particular spot selected for illustration is the intersection of Wall-street, Nassau-street, and Broad-street. The intersection of sewers, pneumatic tubes, gas pipes, telegraph cables, electric light cables, and water pipes, to say nothing of innumerable steam service pipes, is calculated to give rise to uncomfortable speculations as to what might happen in the event of an accident. The illustration reminds one of the diagrams of the veins and nerves of the human body which we find in medical books. We may state that there are twenty-six different pipes, &c., which intersect one another in endless confusion, and how the one at the bottom gets repaired we do not know. The illustration is from a sketch prepared by the New York Board of Public Works.

Accident at Trieste.—An industrial exhibition was opened this week at Trieste, in Austria, by the Emperor. A few days prior to its opening the exhibition buildings were very much damaged by a severe storm, which carried away the iron roof of one of the pavilions. Amongst other things it broke some wires leading to electric lamps. The engineer, whose name is given as Oscar von Heider, appears to have endeavoured to reunite the wires as soon as possible after the accident, and, as the current was on, he received its full force, and was killed on the spot. Why the unfortunate man should have attempted to unite broken wires when the current was on is a mystery. This, however, adds another to the list of untoward accidents, and, judging from the evidence at present to hand, was due to want of ordinary and proper caution. The wires appear to have been insulated, but, of course, the insulation would have to be removed in order to mend them.

Lightning Conductors.—M. Melsens, of Brussels, in advocating his system of lightning conductors, disputes the opinion which has been advanced that danger exists in the employment of a kind of cage formed of many conductors, between which it is feared that flashes would take place by electro-static induction. In reply to this he describes an experiment which, he argues, proves, as did that of Faraday, that no electrical disturbance is possible in a cage with metal sides, placed in perfect connection with earth. The experiment is as follows :—Some kind of animal is introduced into a hollow sphere surrounded by iron rods, set close together, like a cage, placed on the armature of a strong Leyden battery or suspended to the armatures. Endeavours are then made to kill the animal by the electric discharge. The animal, however, far from being killed, does not appear to have been in the least affected by the discharge, which would have killed or injured it had it not been protected by the metal cage. This cage represents M. Melsens' lightning conductor, the animal enclosed within it the house with its inhabitants. M. Melsens also states that his conductors are furnished with numerous points which, he says, certainly do not possess the property of causing electric discharges in the interior of the metal cage, particularly if it be in good connection with one or more damp earths, or in towns, with the gas and water pipes.

Thunder Worship.—In the neighbourhood of the British Colony of Sierra Leone are performed some of the most curious of Pagan ceremonies—viz., those of thunder worship. A tropical thunderstorm is always an awe-inspiring spectacle, and it would occasion little wonder if the natives, impressionable and superstitious as they naturally are, showed an appreciation of the solemnity of the scene presented in a tropical forest at night during such a phenomenon. The thunder worshippers, however, appear to be able to perform their strange rites almost equally well with or without the occurrence of a thunderstorm, and make them the occasion for indulging in feasting and dancing. When real thunder is not available the natives make imitation thunder for themselves by incessant beating of drums and clashing of cymbals, during which some of the women join in a characteristic dance, while the others add to the noise by excited cries and singing. During an actual storm, however, the festival is much more striking. As each flash of lightning breaks the darkness, the whole company of worshippers spring to their feet with loud yells, stamping their feet, and brandishing arms, musical instruments, branches of trees, in a frenzied manner, suggestive of the movements of demoniacs. As the thunder-clap follows the cries are redoubled, gradually diminishing in vigour till a complete silence reigns, disturbed

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only by the fall of the heavy rain-drops, and to be broken again as the next flash of lightning rends the dark sky. Few strangers are allowed to witness these ceremonies.—*Colonies and India.*

THUNDERSTORMS.—A severe thunderstorm passed over Liverpool and the surrounding district on Thursday week. At Burscough it was very severely felt, several trees being struck, and a thatched cottage at Tarlscough being set on fire. A man passing near the house at the time was knocked down, and a pipe he was smoking, when picked up afterwards, was covered with sulphur. Two bonnets which were hanging up in the house were also covered with sulphur. Shortly after eight o'clock, during the severe thunderstorm at Southport, a large waterspout was observed about two miles out to sea. It appeared to pass away harmlessly. A heavy thunderstorm is said to have visited the south-west of England on the previous day (Wednesday), which caused much destruction in Gloucestershire and Somerset. In the latter the lightning set on fire a hay rick on a farm at Nailsea, owned by Mr. Beekes. Despite the efforts of the neighbours the rick was burnt to the ground, and a short distance from it three valuable milch cows were found lying dead, they having, apparently, been struck by the lightning at the same time as the rick caught fire. Between five and eight o'clock in the evening, while the lightning was still very vivid, a great hailstorm passed over Somerset. At Clevedon, on the Bristol Channel, the storm was remarkable for the quantity of hail which fell, the hailstones being described as being of the size of marbles. Great damage was done to ornamental gardens. At Gloucester, the lightning passing through the roof of a house, demolished a chimney, and a boy at work near the dwelling was struck by the flash and a saw knocked out of his hand, but the boy himself escaped injury. Brighton also was visited by a heavy thunderstorm on Thursday, during which a waterspout was seen to pass over the north-western part of the town. Three houses in Hove, two in Selborne-road, and one in Wilbury-road, were struck by lightning, and in one case a stack of chimneys was dislodged, doing considerable damage. No personal injury resulted. The waterspout already mentioned ultimately passed westwards, and burst in the Hove district. It was reported from West Cowes, Isle of Wight, on the same day—viz., Thursday—that a man named Pearse was struck dead by lightning in a field at Skinners, two miles from the town. There was no storm, but distant thunder had been heard all day.

ELECTRIC LIGHT AT BIRMINGHAM.—Messrs. R. Winfield and Co. have sent a letter to Mr. Thomas Avery, mayor of Birmingham, in which they offer to present to the town all the fittings and lamps at the Town Hall, including the lamp outside, upon the condition only that the authorities shall purchase the cables existing between such fittings and their works at cost price. They also state that they are willing to provide the necessary current for the interior of the hall at the rate of £8 per night of six hours, and for the large lamp outside at the rate of £2 per night, Sundays excepted. In reference to this the *Birmingham Daily Post* remarks that this "Very liberal offer will, no doubt, be appreciated by the Town Council and by the public; and there will be a strong feeling in favour of its acceptance, so that the electric light may at least be used as an alternative to gas. The audiences who saw the electric light in operation during the Festival, and those who have had opportunities of seeing it since, will have no hesitation in approving the proposal of Messrs. Winfield, and of supporting the acceptance of their very handsome offer. The purity of the air, the pleasantness of the light, and the sense of comfort and enjoyment experienced during the evening performances at the Festival, in comparison with the heat and stuffiness of the ordinary method of lighting by gas, plead in the strongest way for the retention of the means of electric lighting, so that the system may have a full and fair trial. The approaching concert season, which is about to begin with vigour, will afford the opportunity for such a trial; and we consequently hope that the Town Council will see its way to accept the offer now made. As to the cost of the two systems, it will be observed that the electric light is the dearer—the offer being to light the hall for £8 per night, while the charge for gas is £5 per night; and to this, of course, must be added the expense of purchasing the conducting cables. The last named outlay, however, is all that would fall upon the Corporation funds, as the charge for lighting would be defrayed by persons hiring the hall for concerts or other purposes; and such persons would, of course, have the alternative of using the gas if they preferred to do so. Against the higher cost is to be put the healthiness and comfort of the audiences; and there can be no question that these advantages are well worth a somewhat larger expenditure for lighting."

THE AMERICAN TELEPHONE CONVENTION.—On the 6th inst. the National Telephone Exchange Association of America held its last meeting at Boston, with President Jewell in the chair. The next annual convention was fixed to take place at Cincinnati, Ohio, on the third Tuesday in October. Mr. Choate, of Washington, brought forward a resolution providing for the appointment of a general committee to consider the advisability of holding a national electrical convention at Washington in January or February, 1884. This, however, did not meet with general approval, and fell to the ground. Reports from the various committees were then read as follows: "Mr. T. D. Lockwood, of the Committee on Cables and Subterranean Telegraphy, read a paper giving the results of experiments made with underground wires since the invention of telegraphy, and the disadvantages arising from that method of laying wires. Mr. William F. Jackson, of Detroit, Mich., from the Committee on Telephonic Supplies, described at some length the different appliances used in telephony, but refrained from expressing an opinion as to their merits. Mr. W. D. Sargeant, of Brooklyn, from the Committee on Electrical Disturbances, read a comprehensive paper treating of three subjects—leakage, induction, and earth and atmospheric currents—saying that the increasing number and length of wires prove the value of good insulation and conductivity. No loose or unsoldered joints should be tolerated on a telephone line. The great enemies to long lines were induction and retardation. The latter appeared to be the most difficult to remove. In so-called anti-induction cables retardation was most manifest. When inductive shields entirely enclosed the insulated conductor, the metallic current appeared to remove much of this trouble. A cable, the longest in America, had been recently laid from Newark, N.J., to Jersey City, some ten miles. The conductors in this cable changed their relative positions at every joint of about 1,000ft., and the remedy seemed to be effectual, conversation on a single grounded circuit being carried on without interference with others, and the sound of several Morse wires working from batteries and dynamos was scarcely audible. As to earth and atmospheric currents, it was believed that with well insulated lines of non-magnetic material a degree of perfection might be attainable that would leave but little to be desired."

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THEORY OF MAGNETO AND DYNAMO MACHINES.

XVIII.

The construction of the old Siemens armature is so perfectly familiar to everybody that it is unnecessary to explain it except for the purpose of leading up to its modern form. It consists of a simple coil of wire, arranged in a compact form for rotation in a magnetic field, the two ends of the wire being connected to a split tube of brass on the axle, exactly as in a Delezenne circle or earth-inductor. The current is taken off the two halves of the split tube by fixed springs rubbing against it. If alternating currents are required the tube is split transversely, or at right angles to the axis, into two shorter tubes; and the springs are arranged, not exactly opposite each other, but so that each spring always rests upon the same half of the tube. If direct currents are wanted the tube is slit longitudinally or else obliquely, and the springs are arranged so that their contact is transferred from one half to the other at every semi-revolution. By this arrangement, instead of one spring always touching the same half of the tube, it always touches that half which is positive, whichever that may happen to be; and the other spring always touches that half which is negative. An oblique slit allows a good deal of adjustment; a longitudinal slit is less liable to get wrongly adjusted, or to work itself out of order; otherwise it is immaterial which method of dividing the tube is employed. If any one happens to desire a sketch, they will find a clear one on page 793 of the new edition of "Deschanel;" and on page 796 is shown also the transversely split tube for alternating currents.

The coil may be wound upon wood or any other snbstance, but it is always in practice wound on iron, so as to virtually increase its effective area. For the effect of the iron is to concentrate magnetic lines of force through itself, and a much larger number of lines can be therefore made to pass through a coil containing iron than through a simple coil. An increase in the area enclosed by the coil would have the same effect, but would have the accompanying disadvantage of increasing the length, and therefore the resistance, of the wire; unless, indeed, a proportionately thicker wire were employed. The iron, in fact, enables one to get the advantages of a larger coil in a much smaller compass.

Without entering into the complete consideration of the behaviour of iron cores at this stage, it may be understood that iron behaves as an altogether more magnetically transparent medium than air or ordinary matter. A piece of soft iron introduced into a uniform magnetic field disturbs the lines of force precisely in the same way as a very good conductor of the same shape would disturb a stream of uniform flow in a moderately conducting medium of infinite extent. The "conducting power" of pure iron for magnetic lines of force, or its "magnetic *permeability*," as Sir William Thomson calls it, is about 400 times that of air. This does not mean that anything like 400 times as many lines will pass through a given space if full of iron as if empty. The number will depend on a great variety of circumstances, and will not ordinarily exceed three or four, but iron affords a far more favourable channel to lines of force than anything else.

The field of force in which the armature is ordinarily placed is that enclosed between two circularly bounded pole pieces oppositely magnetised. Even if the armature contained no iron a large proportion of the lines of force would still pass through it, but a very considerable number would jump across by the edges of the pole pieces from D to E (Fig. 1), without being of any use at all. As soon as iron is added to the armature nearly all these are diverted, and pass through its coil, but in ordinary cases there are still some waste lines going direct from one pole piece to the other, and so many the more according as the edges are sharp and the curvatures abrupt.

Suppose, now, the pole pieces to be permanently magnetised, say by means of steel magnets. It will commonly be found that there is a certain angle through which the armature may be turned backwards and forwards without experiencing any magnetic force, an angle which is represented* in the figure by A O B. The lines of force passing through the iron of the armature are, for these positions of the armature, nearly constant. During this part of the rotation, therefore, no work is done, and no E.M.F. generated. The contact springs or brushes must, therefore, be made to pass over the gap of the commutator during this part of the rotation, and the gap may be as large as the angle A O B without any loss being experienced. While the point A of the armature is passing from B to C, the magnetism of the armature is reversed; that is, all the lines of force are taken out of it and put in the other way. In this part of the rotation, therefore, a continuous E.M.F. is generated in the coil; and, if its circuit is complete, a continuous current passes round it.

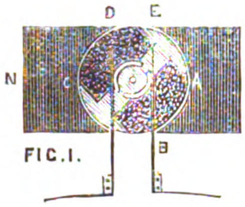

FIG. I.

This current must of course itself magnetise the iron of the armature, and it magnetises it in such a way as most effectively to oppose the motion, *i.e*, it tends to make that end a N pole which is moving from the S and toward the N. As a matter of fact the magnetism induced by the direct action of the pole pieces is the stronger of the two, so that all the induced current can really do is to strengthen the magnetism of the iron armature while it is being torn away from attracting poles, and to weaken it while it is being moved nearer to them; so as altogether to resist the motion when possible, and to prevent its being much assisted when complete resistance is impossible. It is in this way that the mechanical energy is expended in turning the armature which is converted into the energy of the induced current, and this is the immediate cause of the mechanical resistance experienced when the armature is rotated with its circuit closed.

Duplicated Siemens Armature.

Instead, now, of a single coil let the iron be of such a shape that two coils at right angles to one another can be wound upon it, *a a* and *b b* (Fig. 2). The two coils will have four ends: how are these to be joined up to the commutator? There are two distinct plans—the Alteneck and the Brush. Consider the latter first. The Brush method consists in simply

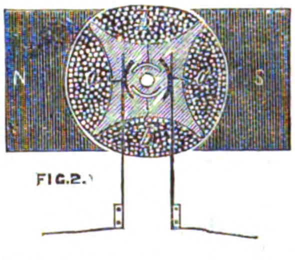

FIG. 2.

duplicating the simple Saxton commutator, in use with the single coil armature, by arranging alongside the split tube another distinct and similar one on the same axle, but with its slit a quadrant in advance of the first one. Only one pair of spring contacts is used as before but they are made broad enough to rest upon a segment of both split tubes at once.† The two coils are thus essentially independent, and they are evidently joined up to the external circuit in multiple arc. The E.M.F. produced by the two can never be higher than that due to the most active of the two coils above, but it may fall below it; in fact the difference of potential between the brushes, when the machine is running with the external circuit open, can

* This neutral angle A O B as represented in the figure is larger than it would really be.

† The commutator in Fig. 2 is intended to represent this, but it is desperately diagrammatic. The coil *b b* is in the neutral position.

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be shown to be the arithmetic mean of the E.M.F.'s generated in each coil alone, provided the resistance of each coil is the same. The gaps in the commutator tubes must, therefore, be sufficiently wide to cut either coil completely out of circuit when in its inactive position, *i.e.*, in the angle AOB; or the available E.M.F. would fall off greatly at every quarter revolution. But even when the gaps are wide enough there is still a good deal of variation possible, and the current from a Brush machine is always, therefore, rapidly fluctuating; so that, as Prof. S. P. Thompson observes, a telephone circuit arranged in its neighbourhood keeps up a continual loud buzz. It may be possible to calculate the shape of the iron of the armature so that the E.M.F. generated in each coil during the time the spring touches its commutator segments shall be really constant, and the current would then be steady; but this has not yet been done.

It may be instructive just to consider what the variations of E.M.F. would be, if for simplicity we suppose the armature to contain no iron, and to be spun in a uniform magnetic field at a steady pace. The E.M.F. in each coil would be proportional to the sine of the angle which a normal to its plane makes with the lines of force; hence, as the two coils are at right angles to each other, their joint E.M.F. will be

$$\frac{\sin\theta + \cos\theta}{2}, \text{ that is } \tfrac{1}{2}\sqrt{(1+\sin 2\theta)}$$

A function which varies from 1 to 1·414, and back again, four times in every revolution. [It is no use to give θ negative values, because of the commutator.]

Multiplex Armature.

While we are upon this Brush mode of connection we may as well go on to consider the case of more than two coils, say 3 or 4 or 5, or any number, n. The commutator will be n-fold likewise, having its n split tubes with sufficiently wide gaps arranged end to end on the axle, and the single pair of springs broad enough to rest upon all at once.

Some one of the coils will now probably be always cut out of circuit by its commutator gaps, and in some positions two may be so cut out. The internal resistance of the armature will, therefore, be about $\frac{1}{n-1}$th of the resistance of any one of the coils, but it may momentarily rise to $\frac{1}{n-2}$th.

The highest available E.M.F. will again be the arithmetic mean of all the E.M.F.'s generated in all the coils; and, again, considering for simplicity the case of a plain wooden armature in a uniform field, this E.M.F. will be

$$\frac{1}{n}\left[\sin\alpha+\sin(\alpha+\beta)+\sin(\alpha+2\beta)+\ \ldots\ +\sin\Big(\alpha+(n-1)\beta\Big)\right]$$

where α varies from 0 through $\frac{1}{2}\beta$ to β, and where $n\beta = \pi$. The value of this expression is

$$\frac{\cos\left(\frac{1}{2}\beta - \alpha\right)}{n\sin\frac{1}{2}\beta},$$

which varies, therefore, from $\frac{1}{n}\cot\frac{\pi}{2n}$, its smallest value, to $\frac{1}{n}\operatorname{cosec}\frac{\pi}{2n}$, its greatest.

If $n = 2$ this gives us, as we already know, a variation between 1 and $\sqrt{2}$,

If $n = 3$ the variation is between $\sqrt{3}$ and 2,

For $n = 4$ it varies from 2·414 to 2·613; and so on, till for eight or ten coils it becomes nearly constant. [$n = 10$ gives a variation from 6·314 to 6·392.]

So much for the Brush form of commutator, which, as far as we are aware, has never been actually applied to the Siemens form of armature, but only to the Pacinotti form. It could as easily be applied to one as to the other, but it can hardly be considered so good a mode of connection as the Alteneck; for its multiplicity of rubbing surfaces, and the unavoidable variations in the strength of its current, must be very conducive to sparking and to an unreasonable amount of wear and tear.

We must defer the consideration of the Alteneck mode of connection until next week.

CORRESPONDENCE.

TELEGRAPHING WITHOUT WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

(Translation.)

Sir: Permit me to express my surprise at the article in the *Dundee Advertiser*, reproduced by you in your issue of the 16th September—an article which seems to indicate that in England people ignore all the researches and experiments that have been made on the subject of telegraphing without conducting wires. Mr. Lindsay's researches are well known to me, and I have given details of them in the various editions of my "Exposé des Applications de l'Eléctricité," and in several other publications; but long before his time this idea was put forward, and most interesting experiments were tried in America, England, and Germany, to which I call your readers' attention. Those of Mr. Preece were made on a larger scale, however, and are in that respect more important.

The first experiments made with the object of telegraphing without wires were undertaken by Messrs. Morse, Gal, Vail, and Rogers on the River Susquehana, at Hâvre de Grâce, near Baltimore, in 1844. Details of these experiments are given at length in Mr. Vail's work on "The American Electro-Magnetic Telegraph," published in 1847 (see p. 60 of the English edition and 66 of the French edition). They were made across the River Susquehana, which was 1,609 metres broad at the locality of the experiments. Later on, experiments of the same kind were made by M. Van Reese between Portsmouth and Gosport, and Mr. Wheatstone watched them with great interest. In 1856 M. Gintl, the inventor of the duplex telegraph systems, repeated them by simply laying the earth under contribution. Then came Mr. Lindsay, who put forward the notion that by this means the problem of uniting America and Europe by the telegraph would be solved.

Finally, in France, M. Bouchotte, in 1878, and M. Bourbouy, in 1871, tried experiments of the same kind under more or less favourable conditions. M. Bourbouy, indeed, had established quite an organised telegraphic system at the time when Paris was surrounded by the German armies, to establish communication between Paris and the country. If peace had not been concluded, it is probable that use would have been made of this system, despite its complication. Accounts of all these experiments were given at different times in different papers and scientific works; and it is a curious fact that, in France as in England, at each fresh series of experiments the solution of the problem was regarded as a novelty. M. Bourbouy's experiments were made on the Seine between Austerlitz Bridge and Napoleon Bridge, distant about two and a-half kilometres from each other.

As you see, Sir, Mr. Preece has experimented on the largest scale, since the extent of that part of the circuit in which there were no conducting wires amounted to more than seven miles, and the result obtained is interesting to note.

In an article published in *La Lumière Electrique* for 19th August, 1879, I gave a *résumé* of the history of these different experiments, and also the theory of the effects obtained; possibly this article might interest your readers.—Yours, &c.,

Th. du Moncel.

Lebisey, près Caen, September 17, 1882.

Erratum.—In Mr. Kingzett's letter in our last issue on "The Influence of the Positive Electrode in a Battery," line number 14, commencing "The electromotive force," to line 18 inclusive, should be all one sentence, and instead of a full stop in line 16 there should be only a comma. The sentence should read as follows:—"The electromotive force required to decompose the dilute sulphuric acid is, of course, constant; only, in the case last referred to, the E.M.F. of the battery currents is supplemented by the energy of the chemical affinity of copper for oxygen."

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TRIALS WITH THE CROMPTON-BÜRGIN MACHINE.

The following tables give the results of trials recently made at Messrs. R. E. Crompton and Co.'s arc works, Chelmsford, with the horizontal shunt Crompton-Bürgin dynamic machine, the particulars of which we are enabled to publish through the courtesy of Messrs. Crompton and Co.:—

TYPE C_3. BOBBIN 0.545 OHMS. FIELD MAGNETS 2 IN SERIES. RESISTANCE 10.5 OHMS.

Number of Trial.	Speed.	Resistance in.		Current in.			E.M.F.		Percentage of.			Horse Power transmitted to Dynamo.	Total Electrical Horse Power.	Useful Horse Power.	Percentage of useful to transmitted Horse Power.
		External Circuit.	Total.	Bobbin.	Field Magnets.	External Circuit.	In Bobbin.	At Brushes.	Work lost in Bobbin.	Work lost in Field Magnets.	Work done in External Circuit.				
1	1450	3.310	3.055	38.70	8.00	30.70	118	97	17.8	14.6	67.6	6.40	6.15	4.16	65.0
1A	1500	2.335	2.455	45.74	7.40	38.34	113	88	22.1	11.1	66.8	7.10	6.90	4.60	65.0
2	1400	1.822	2.100	51.62	7.00	44.62	108	80	26.0	9.2	64.8	7.48	7.49	4.86	65.0
3	1520	1.822	2.095	52.90	6.90	46.00	110	82	25.8	8.5	65.7	8.82	7.80	5.18	58.7
4	1420	1.822	2.095	53.25	6.60	46.65	111	82	25.9	7.8	66.3	8.20	7.92	5.30	64.6

TYPE C_3. BOBBIN 0.545 OHMS. FIELD MAGNETS 4 IN SERIES. RESISTANCE 42 OHMS.

Number of Trial.	Speed.	Resistance in.		Current in.			E.M.F.		Percentage of.			Horse Power Transmitted to Dynamo.	Total Electrical Horse Power.	Useful Horse Power.	Percentage of useful to transmitted Horse Power.
		External Circuit.	Total.	Bobbin.	Field Magnets.	External Circuit.	In Bobbin.	At Brushes.	Work lost in Bobbin.	Work lost in Field Magnets.	Work done in External Circuit.				
5	1420	3.320	3.605	30.20	1.80	28.40	111	92	15.0	4.1	81.9	4.55	4.40	3.60	79.0
6	1480	3.320	3.605	30.20	1.80	28.40	111	92	15.0	4.1	81.9	4.54	4.40	3.60	79.1
7	1630	2.470	2.875	39.30	1.86	37.44	113	92	18.9	3.3	77.8	6.44	5.92	4.60	71.3
8	1650	5.890	5.705	23.24	2.24	21.00	132	120	9.5	6.7	83.8	4.50	4.15	3.47	77.0
9	1650	5.890	5.705	23.24	2.24	21.00	132	120	9.5	6.7	83.8	4.27	4.15	3.47	81.3

TYPE C_4. BOBBINS 0.298 OHMS. FIELD MAGNETS IN SERIES. RESISTANCE 42 OHMS.

Number of Trial.	Speed.	Resistance in.		Current in.			E.M.F.		Percentage of.			Horse Power Transmitted to Dynamo.	Total Electrical Horse Power.	Useful Horse Power.	Percentage of useful to transmitted Horse Power.
		External Circuit.	Total.	Bobbin.	Field Magnets.	External Circuit.	In Bobbin.	At Brushes.	Work lost in Bobbin.	Work lost in Field Magnets.	Work done in External Circuit.				
10	1760	2.380	2.558	37.30	1.80	35.50	95	84	11.7	3.8	84.5	5.04	4.75	4.02	80.0
11	1800	2.380	2.558	39.34	1.90	37.44	100	88	11.5	3.8	84.7	5.44	5.30	4.50	82.7
12	1820	3.360	3.418	29.10	1.90	27.20	99	91	8.8	5.2	86.0	4.75	3.85	3.32	70.0
13	1800	4.46	4.338	21.95	1.90	20.05	95	88	6.9	7.3	85.8	3.99	2.79	2.40	60.0

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ON SOME APPARATUS FOR USE IN CONNECTION WITH ELECTRIC LIGHT MEASUREMENT.*

BY ROBERT SABINE, C.E.

Having occasionally to make measurements requiring some degree of exactness of the electrical and photometric values of electric light systems, in reference to the power expended in maintaining them, I had for some time difficulty in finding apparatus specially adapted for this work, the electrical instruments which were suitable for continuous current systems being, as a rule, unsuitable for alternate currents. I was, therefore, induced to design some apparatus for my own use, which I have found convenient and sufficiently exact for practical purposes.

I. The Photometer.

The absorption of light when passing through translucent media has hitherto been almost entirely unemployed for photometric purposes. Lampadius, it is true, suggested the reduction of any ordinary light to its vanishing point by means of thin sheets of horn, assuming that this vanishing point might be taken as a fixed unit of intensity—a method which De Limency and Secretan proposed to modify by employing sheets of paper instead of horn—and Count Xavier de Maistre and Quetelet suggested the employment of wedges of blue glass for purposes of stellar photometry. But in neither instance was anything approaching to a practical photometer produced.

The photometer which I am about to describe is based upon the partial equalisation of any two lights under comparison, by interposing in the path of the rays of each light a sufficient thickness of absorbing material, the final adjustment being made by a slight alteration of the relative distances of the lights from the photometer.

Instead of comparing the lights directly with each other, I find that much better results are obtained by comparing them singly with a third light, which is constant.

This constant light I obtain by allowing the rays from a small portion of the bright part of a paraffin flame to pass through suitable diaphragms; the advantage of this method being that so long as the diaphragms are not too large, any trifling irregularity in the paraffin flame, through burning higher or lower, does not affect the small portion of the bright part which is employed, and, therefore, the utilised light is practically as nearly constant as possible. The form of apparatus which I use is shown in section in Fig. 1, in which the photometer is placed, for convenience of illustration, vertically, as if measuring a light immediately above it. The graduated scale, a, a^1, upon which the photometer travels, turns upon a centre carried by a stand (not shown in the drawing), and can be elevated or depressed to any desired angle. The photometer consists of a square brass box, d, d, on one side of which is a draw tube and eye piece with lens, g; and on the other side a tube, f, carrying a collar by which the paraffin lamp $b\ b$ is supported, and may be kept in a vertical position at whatever angle the scale may be directed. The chimney of the paraffin lamp is of copper, and opposite to the bright part of the flame is provided with a tube, c, in which are a thin pane of glass and two diaphragms, and at the back another tube, c^1, in which a dark glass is fitted for observing, from time to time, the flame, to ascertain that it is burning in the proper position.

At p_1 is a thin sheet of translucent material, part of its inner surface being observed by the eye at g.

The light to be measured is placed at a distance (under three feet if possible) beyond the end a of the scale, so that its rays fall upon the face of a thickness of translucent material, p, inserted in a suitable guide at the side of the photometer, its inner surface being observed by the eye at g, reflected by the prism e, which occupies half of the field of view. The thickness of the interposed translucent material p is adjusted until the illuminations of the two halves of the field of view are as nearly equal as this adjustment allows; then the distance between the light to be measured and the face of p is adjusted by causing the photometer, which is mounted on rollers, to travel on the scale until the two halves of the field of view are equally illuminated.

The illustration shows the photometer directed vertically upwards; but as the lamp may be turned with the collar which supports it, the scale may be placed horizontally or inclined at any desired angle upwards or downwards. In order to lessen the effect upon the eye of slight differences of colour between the lights to be compared, there are inserted just at the top and bottom of the line in which the two halves of the field of view meet, small strips of highly coloured glass. The effect of the presence of these, when I am observing, is to render the eye partly unconscious of small differences of tint of the middle portions of the field of view, without reducing its sensitiveness for appreciating the balance of illuminating effect.

The comparison with the horizontal light of a standard candle is done by placing the photometer horizontally and putting the candle at the end a of the scale, reducing at the same time the thickness of the translucent material p, until a balance is nearly obtained, and finally adjusting by sliding the photometer along the scale.

The intensity of the light which penetrates from the paraffin lamp to the inner surface of the translucent sheet p_1, and which is the constant of comparison, we will call λ. We may assume that of the light which falls upon the surface p, the fraction which is scattered and reflected bears to it a constant relation, r.

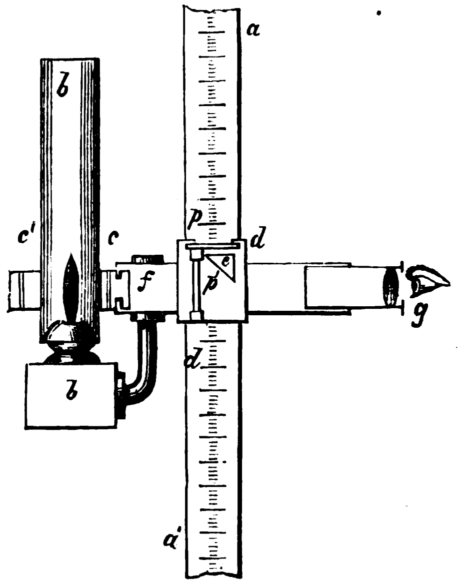

Fig. 1.

Let L be the illuminating power of the measured light in the direction of the photometer, n the thickness of absorbing material, and D the distance of the source of light from p. Then the light which reaches the surface of p when a balance is obtained will be :—

$$\lambda = \frac{(- r)\ L\ m^n}{D^2},$$

m being the co-efficient of translucency of the absorbent body p; that is to say, the intensity of light which succeeds in reaching the inner surface of a unit thickness of p, when a unit intensity of light enters the outer surface.

Similarly, for the standard candle, the illuminating power of which is l, its distance d, and the interposed thickness of the same translucent material n_1 :—

$$\gamma = \frac{(1 - r)\ l\ m^{n1}}{d^2},$$

the relation of these two lights is, therefore :—

$$\frac{L}{l} = \left(\frac{D}{d}\right)^2 m^{n1 - n}$$

it being assumed that the light of the paraffin lamp has remained constant during the two observations, and that the atmosphere has not acted as an absorbent.

The co-efficient of translucency of the interposed absorbent

* Paper read before British Association meeting, Southampton.

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material must, of course, be very carefully determined, because upon the value of this co-efficient being exactly known depends the accuracy of the results obtained as much as upon the accuracy of the final adjustment of distance.

This co-efficient I determine by employing a strong steady light, and taking observations of distance first with one, then several (say, n) thicknesses of the material.

If the observed distance with one thickness is d_1, and that with n thicknesses is d_n:—

$$m = \left(\frac{d_n}{d_1}\right)^{\frac{2}{n-1}}.$$

I find that the readiest way is to take alternately the distances with one and three thicknesses, because then

$$m = \frac{d_3}{d_1},$$

a simple relation which saves calculation.

The comparison of one with two thicknesses was found to be objectionable, as any error of observation was exaggerated, whereas when more than three were taken for the co-efficient the illumination of the field became weakened, and the observations were less accurate.

It is not necessary that the translucent body at p_1 should be either of the same quality, tint, or thickness, as that used at p, as it is simply intended to provide a constantly illuminated surface for comparison; but the thicknesses of the material used at p must be carefully selected, and must be as uniform as the eye is capable of detecting. The material which I have found to be most convenient for use as an absorbent, consists of thin plain photographic paper, which is very uniform in texture, and is easily procurable.

In an earlier form of this photometer, the comparison was made direct with a standard candle, by enclosing the latter in a candle-holder consisting of a closely-fitting tube, furnished with a spring, which pressed the candle up against a top rim, and maintained it at a constant level in a suitable dark lanthorn.

It was found, however, that a candle so circumstanced always gave a reduced light, and that other lights compared with it appeared to be exaggerated in photometric value; moreover, the difference of colour between the light of a candle and that of most electric arc lamps is very striking, while the colour of a paraffin flame is between the two, and the difference, therefore, between it and either the candle or electric light is less embarrassing.

When it is desired to employ Schwendler's method of observing the illuminated surfaces through coloured glasses, I place them before the eye-piece g.

II. The Current Dynamometer.

The current dynamometer is constructed to be equally applicable to continuous and alternate currents.

It consists of two circular flat coils of thick copper, a and b, as shown in outline in Fig. 2.

One of the coils, a, is carried on a beam, together with a counterweight, by a bifilar suspension. This suspension is done by a thin silk thread, the two ends of which are fixed to a torsion-head at d, its middle portion passing under a small friction pulley, p, attached to the beam. By this means the strain upon both sides of the bifilar thread is equal. The ends of the movable coil a are amalgamated, and dip into two suitable mercury cups (1 and 2). In the position of rest, the torsion-head of the bifilar suspension is turned so that the plane of the coil a forms an angle of 5deg. to 10deg. with the plane of the coil b; its angular position being observed by a mirror attached to the suspended coil, which projects a spot of light upon a scale placed at a constant distance. The second flat coil b is mounted upon grooved copper feet, which slide upon two copper rails, c, c^1, keeping coil b at right angles to the rails and facing coil a, but at distances which may be readily varied.

The dynamometer is inserted in the circuit whose current is to be measured, between terminals connected with the points 1 and 3. The current from M enters the system at the terminal connected with the mercury cup (1), circulates (right-handed) through the suspended coil a, which it leaves by the mercury cup (2), passes along the rail c^1, to the sliding coil b, in which it circulates (left-handed), passes to the rail c, and so back to the circuit.

The repulsion which takes place between the coils results, of course, in the deflection of the suspended coil to a greater or less degree, according to the strength of the current and the distance between the coils. If this deflection is insufficient to place the coil a parallel to coil b the latter is slid along the rails nearer to a, but if the repulsion cause a to be deflected beyond its parallel position coil b is drawn back until the light point settles to the zero of the scale.

The sluggishness of the mercury in the cups is utilised to check any continued oscillation.

The scale of the instrument is placed between the rails. It was calibrated by comparison with a tangent galvanometer, the position of the sliding coil b when the parallel position of the suspended coil was obtained being marked for each ampere of current; and it was found that beyond one ampere the distance was practically proportional to the current, but below one ampere this proportion did not obtain, probably due to want of symmetry in the coils themselves.

As the deflection of the suspended coil is always the same, the repelling force acting upon it is constant; and if this force is directly proportional to the square of the current, and inversely to the square of the distance between the coils, it would follow that the current and distance should be directly proportional to each other.

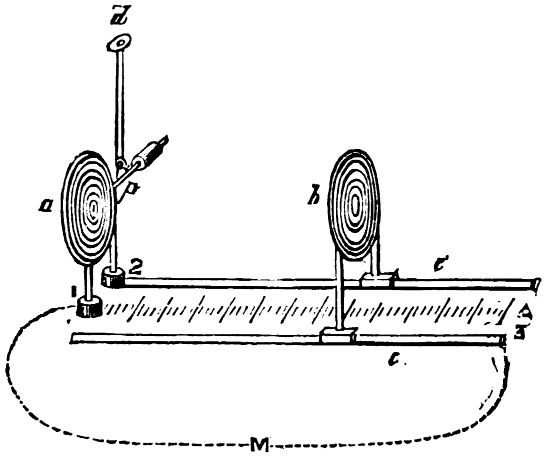

Fig. 2.

The resistance to deflection of the suspended coil must, of course, be kept as constant as possible. This I have attempted by using unspun silk for the bifilar suspension, and putting the threads at a sufficient distance apart to cause the resistance to deflection to be due more to the lifting of the coil than to the torsion proper of the threads.

By making the current go through the two coils in derived circuit instead of in series, the sensitiveness becomes reduced to half; the range of the scale being proportionately increased. For very strong currents the range of the scale can be increased to any extent by properly arranged shunts.

When measuring very strong currents the disturbing effect of the earth's magnetism has to be considered. In order to allow for this, before making an observation I place a coil of wire of the same resistance as one of the working coils, but double-wound, upon the rails in place of b. This dummy coil has no deflecting effect upon the suspended coil, but renders the current moving through it the same as when b is in its place. When this is done the effect of the earth's magnetism is to cause a slight deflection of the suspended coil from its position of rest, to which it is then re-adjusted by turning the torsion-head.

So far I have found this method to be convenient. Although the apparatus I use is home-made, it has the advantage of being strictly a zero method, and the instrument is not

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encumbered with any table for the reduction of observations.

III. The Potential Dynamometer and Resistance Measurer Combined.

This instrument is designed to fulfil a double duty, and as a potential dynamometer is equally available for continuous and for alternate currents.

It consists of two circular coils of moderately fine copper wire, one of which is held by a bifilar wire suspension inside the other, as in Weber's well-known dynamometer. When required, however, to be used as a galvanometer, the suspended coil can be readily removed and replaced by a magnet needle.

When used as a dynamometer with a potential difference of one Daniell between the terminals, the suspended coil is deflected to between 100 and 150 divisions of a reflected light point falling upon a scale at a distance of 100 centimetres. This reading, which remains very constant, can, however, be adjusted for a greater or less degree of sensitiveness by altering the distance apart of the bifilar suspending wires.

The reading with one Daniell potential-difference is the constant of the dynamometer, and is obtained by inserting between the terminals a Daniell cell having a resistance sufficiently small that it may be neglected without appreciable error.

When any greater potential-difference is to be measured, an adjustable resistance is inserted in the circuit in order to reduce the current (and deflection) to the same value as the constant. For instance, if a potential-difference, x, of an electric arc is to be measured, the terminals of the lamp, or connections from the carbons, are inserted, with an adjustable resistance which is gradually reduced to r, so as to reproduce the constant deflection of the light-point. The constant current is then represented by two equations:—

$$C = \frac{e}{\rho}$$

ρ being the resistance of the dynamometer wires, and e, volts, the electromotive force of the Daniell, and :—

$$C = \frac{x}{r + \rho},$$

assuming that the resistance of the arc may be neglected, as it is very small in comparison with $r + \rho$.

The electromotive force of the arc is therefore :—

$$x = c\left(\frac{r}{\rho} + 1\right) \text{ volts.}$$

The effect of the earth's magnetism upon the suspended coil is, of course, entirely eliminated, the current being the same in each observation.

The resistance box, which I use in connection with this dynamometer, is constructed with adjustable resistances between one and 100,000 ohms, and has in addition the usual proportion-coils of a Wheatstone bridge.

When it is required to measure the wire resistance of a circuit, this resistance box is employed as a Wheatstone bridge. The suspended coil of the dynamometer is removed, and a magnet-needle inserted in the centre of the stationary coil, so as to readily provide a galvanometer which is sufficiently sensitive for measuring small resistances with the aid of the constant Daniell cell, thus avoiding the necessity of providing separate instruments for this purpose.

IV. The Mean Pressure-Indicator.

The determination of the horse-power performed by the steam engine is usually made by taking diagrams with a Richard modification of Watt's indicator. There are, however, some objections to the use of this instrument for this purpose, arising from the necessity of special fittings, besides the fact that these diagrams, obtained at considerable trouble, give more information than is wanted for the object in view.

The horse-power is calculated only from the mean pressure, which I have endeavoured to arrive at in a more simple way. Instead of taking indicator-diagrams, I have obtained very good results with a simple Bourdon pressure-gauge, so arranged that the mean pressure at either end of the cylinder can be read off at once, and the horse-power obtained at any moment with very little trouble.

For this purpose I attach to each end of the cylinder a pressure gauge, the pipe leading to which is throttled sufficiently to allow only of a small entry and exit of steam at each stroke. This throttling may be carried to such an extent that the pointer of the gauge rises comparatively slowly to the mean pressure, above and below which it makes small oscillations.

In the arrangement of the gauge, the attachment to the blow-off cock of the cylinder is conveniently made by a short length of thick india-rubber tubing, strengthened by a double serving of tape, and lashed. Between this and the gauge I insert a tube of brass containing, in a socket coupling, a screw plug, through which a small hole is bored. Every precaution has, of course, to be taken to prevent condensation of steam in the throttle or in its immediate neighbourhood. For this purpose I keep the throttle-tube at a temperature considerably above the temperature of the steam by placing the flame of a lamp underneath it. Between the throttle and the pressure gauge is a small blow-off cock. Before observing the mean pressure this cock is opened, and steam blown through. It is then closed, and the pointer of the gauge rises by a series of jerks up to the mean pressure, about which it oscillates through a small arc, the mean point being easily observed.

CONTACT MAKERS OF DELICATE ACTION.*

BY PROFESSOR H. S. HELE SHAW.

The author has been engaged in designing a speed indicator in which it is essential to have the uniform motion of a revolving disc. This disc is subject to varying resistance, so that for driving it, clockwork, even though powerful and expensive, could scarcely be depended upon. It, therefore, seemed best to employ an electro-magnet acting on a ratchet wheel and controlled by a clock. This clock for the purpose might then be a common one, with lever escapement. Upon inquiry there appeared to be no contact maker at once absolutely reliable, suitable for continuous use, and at the same time sufficiently delicate in its action.

In an instrument of this kind for completing circuit it is necessary to ensure such a close approach of the surfaces forming the opposite poles as practically amounts to absolute contact. With small differences of potential and without previous contact, the exact distances across which the current will flow appear to be at present unknown. According to Professor Guthrie the terminals of 50 or 60 Grove cells may be brought to within 1-1000th of an inch without any indication of the passage of a current. Professor Tyndall says that a battery of more than 1,000 cells is required to cause a spark at 1-1000th of an inch, and Professor Sylvanus Thompson mentions 1-10,000th of an inch as the distance. To ascertain the quantity exactly appears impossible without the use of an instrument of such refinement as Whitworth's millionth measuring machine, a modification of which might be very appropriately employed for the purpose. The distance, no doubt, is extremely small, and the consequent difficulty in the way of ensuring electrical contact when the opposite poles are the surfaces of two solids seems to merit a brief consideration.

The ways in which two such surfaces are brought together may, for convenience, be divided into (1) a relative motion of the two terminal surfaces, normal to both; (2) a motion tangential to both; (3) a motion compounded of these two. The first mode is very common with rapid contact makers, such, for instance, of those with electric bells and telegraphic transmitters, but these require an appreciable amount of force to work them. That contact makers of this kind are not suitable with delicate clocks is the testimony of every clockmaker to whom the author has spoken. One of these

* Paper read before British Association, Southampton meeting.

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instruments of very delicate construction required the weight of nearly one gramme to ensure electrical contact, and then could not be entirely relied upon. There is no doubt that when two surfaces of solids touch only lightly the area of contact is exceedingly small. This area may be made to increase by increasing the pressure with which they are brought into contact. The conditions of the problem under consideration do not admit of this being done to any appreciable extent. Thus, even when chemical compounds are prevented from forming on the surfaces, dust and particles floating in the air are liable to become deposited between them, and render contact uncertain.

For these reasons contact of the second kind, which is known as rubbing or sliding contact, has been largely adopted. This action may be made perfectly reliable, and is suitable where the motion is not rapid, as, for instance, with switches and commutators. But considerable energy may be absorbed in overcoming friction. Those clockmakers who employ it appear to do so only for large clocks. The third method has, as far as the author is aware, been adopted in only one way, though in that way with eminent success. A contact maker of this kind is used by Mr. Hargreaves, of Leeds, who has had it at work for fifteen years. A metal roller with rounded edge runs upon and between two metal rails of circular section, thus making contact between them. Contact is broken when the roller passes over a gap or joint to another pair of rails. When the roller is moving along the rails, there is a slight rubbing action, by reason of its resting between them. This is almost certain to produce electrical contact, which is even found to occur without failure when the whole is covered with dust. The metal employed is gold, which, with a weak current, is found to last much better than even platinum. With a strong current the metal oxidises, and moreover, though working admirably with a heavy pendulum, the resistance is too great for a delicate escapement to overcome.

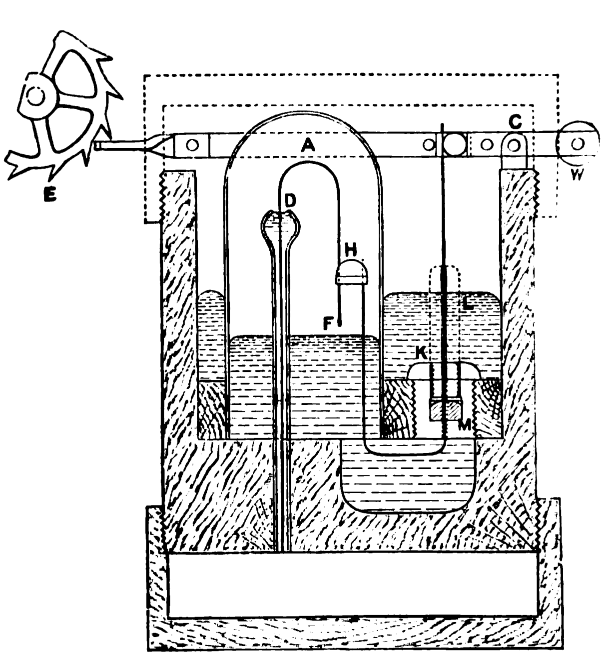
The use of a liquid terminal with which the other terminal (being solid) is brought into contact obviates most of the foregoing difficulties. Of all liquids mercury is the only one which can be practically employed. There are two objections to its use which have hitherto prevented its employment for more than temporary and experimental purposes :—

1. The fact that it readily combines with oxygen on the passage of an electric spark.

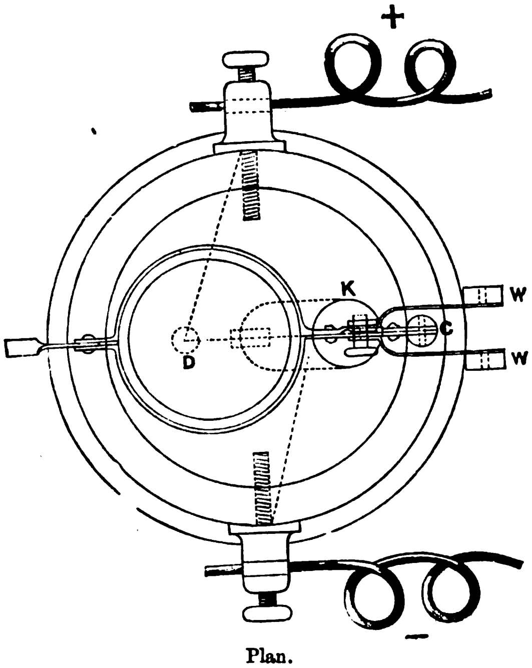
2. The difficulty of rendering a contact maker of this kind portable.

The author has endeavoured to overcome the first of these by causing contact to be made in a gas which has no action on the mercury. The way in which this is done is as follows : A short glass tube, closed at its upper end (such as an inverted test tube) is filled with mercury, and inverted in a vessel of mercury. The mercury is then partially displaced by hydrogen gas. A very light bent lever working on a pivot is connected with a platinum wire, which passes through the mercury into the gaseous space. It there makes contact between the mercury below and a smaller quantity in an insulated capsule within the tube. The lever is worked from the outside by mere contact with the escapement wheel of an ordinary clock, which, owing to its extreme sensitiveness, is quite sufficient to do this. The positive and negative poles of the terminals are connected respectively with the mercury in the capsule and that in the vessel. It is evident that although the lever is always in electrical contact with the mercury in the vessel, the circuit is only completed when it is brought into contact with that in the capsule.

Various experiments have been made with this instrument, and the result has been completely satisfactory. With a battery of fifteen Grove cells the surface of the mercury was brighter at the end of half an hour than at the beginning of the experiment, although a much more brilliant spark was visible than when contact was made in air. After three weeks of intermittent working for periods of sometimes as much as twelve hours, but with weaker batteries, the mercury remained quite clean.



Sectional Elevation Shift.



Plan.

Electrical Contact Maker (full size).

The present form of the instrument is shown in the annexed figure*. The general action is similar to the one already described, A being the gaseous space, D the capsule of mercury, E the escapement wheel. The chief improvements to be noted are :—

1. Contact is made and broken at F instead of at D, thus preventing sensible loss by volatilisation from the small quantity of mercury in the capsule. The wire D F is insulated from the bent lever by the glass junction at H.

2. Portability is secured by having a plug, K, shown in dotted lines, which can be screwed down and a gland, L, by means of which the wire can be packed by an india rubber washer, M. The lever and balance weights W W are made to go within the lid, which can be taken off the bottom and screwed on to the top (as shown by the dotted lines). This keeps in any loose mercury above the plug.

3. The lever is so arranged that contact is only of momentary duration, a point of no little importance in connection with the constancy of the battery.

* We are indebted for these illustrations to our excellent contemporary *Nature*.

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LOCAL BOARDS AND THE ELECTRIC LIGHT.

The decisions of the various local boards which have had proposals under consideration for introducing the electric light to their several districts are not very encouraging to local companies. Whatever may be the fortunes of the parent companies, it seems already pretty evident that their children, the concessionnaires for particular districts, are beginning to realise their true position, a position far removed from that which they expected to occupy when they paid for their concessions. From the reports of the statutory meetings of the later companies we gather that some disappointment is felt that they did not come into existence until the great wave of speculation began to descend. We think they may take comfort, if they really mean business and not speculation, from the prospects of some of the earlier concerns which floated on the top of the wave. A trade even in concessions has its drawbacks, for purchasers have in some instances already proved to be mere speculative dogs-in-the-manger, who earn no royalties and will let nobody else earn them either. Other instances there are, however, of local companies making an effort to secure a return for their purchase money, and these, we say, will not be encouraged by the want of success which has so far attended their efforts.

First of all they have discovered, as we predicted they would some time ago, that their supposed monopoly is in reality no monopoly all. The local boards have in almost every case that has come to our notice received applications to supply electricity from more than one company; and, in fact, the local company finds itself exempt from none of the risks and disappointments of competition, except in respect to the parent company. That these small offshoots will make headway against the established trees, the best of which have not bartered concessions, is highly improbable. They have found out also, or rather the local boards have themselves found out, that the electric light can be established without the help of a local company. The local boards can do it on their own account, and, unhappily for the local monopolists, are free to employ what system seems to them best. Further, as touching the application for licenses, the local authorities for the most part are—as was stated at Leeds the other day—practically masters of the situation. The attempt to put pressure upon them by threatening application to the Board of Trade for a provisional order is not likely to succeed. From numbers of places the result of such applications has been to refer them to a committee of inquiry, who have speedily reported that the hands of the board cannot be forced in that way. In general the terms of their decision have been, as at Scarborough, that it is undesirable to grant a license under the Electric Lighting Act *at present;* that is to say, they would not commit themselves and the town whose interests they represent to the adoption of any one company's system.

This last is one of the difficulties which, in practice, will be experienced in working the Act. In the event of a rejected applicant referring his case to the Board of Trade, and seeking a provisional order, what is to be said if the local authorities object to the system proposed for them? The Act is framed as if electrical systems of lighting were one. They are legion; and the duty of making a selection, or of selecting one simply because it is first to apply, is, probably, not such as the Board of Trade would care to undertake, especially in opposition to the local boards chiefly interested. The process of natural selection in this, as in all other practical matters, will, however, determine what is best; but, meanwhile, we cannot blame the vestries for being cautious in making a choice, though the electric lighting companies will, perforce, suffer by the delay. Their chief reliance must be on their efforts to perfect the appliances of which they are the owners, in completing their plant in readiness for the demand, and in generally adopting all legitimate means of bringing the advantages of their system under public notice. Even where the privilege of installation is not assigned to them, but is appropriated by the local authorities, the manufacture and sale of appliances ought still to be a fairly lucrative business. Local boards cannot infringe patents, though they are free to use them for a consideration; and, in view of this fact, it may not always be prudent to oppose the wishes of any given town, or to provoke it unnecessarily by references to the Board of Trade.

As regards the local boards, their position is not an

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enviable one just now. Such of them as are of the go-ahead sort, or whose course has been clear from the first—as at Dundee and at Southport—have come to a decision, and are about to act upon it forthwith. But in the vast majority of places an application for a license to introduce the electric light is the signal for a most distressing and perplexing conflict of interests. When they have got over their first fright of being compelled to grant a license to some outsider or be deprived of their rights altogether, they begin to remember that there is gas; perhaps, too, that they have personally large shares in the local company which supplies it. They want the electric light, but they do not want to depreciate its rival. If the electric light comes in, gas light must to that extent go out. Then there are the ratepayers. If we do not give them the advantages of electricity we shall be blamed for want of enterprise; whilst if we do, and the rates go up, we shall be expelled for our extravagance. Such is the dilemma of local magnates. Add to this the fact that they know nothing of electricity, and that their local surveyor did not include that branch of science in his professional studies, their unfitness to decide between conflicting claims upon their patronage must be as painful to them as it is conspicuous to others. Here, again, time will work miracles. The surveyor will learn something about electricity, and the local board will have leisure to take wise counsel.

Time, however, some people seem to think, will favour the gas interests also. From the point of view of the gas consuming public it is satisfactory to note this change of opinion as to what those interests are. They used to consist in supplying the worst gas possible for the highest price obtainable. All this is changed; their true interests are to purify the gas, improve the burners, and lower the charges. The electric light has enlightened them on these points, and, if for nothing else, the public ought to thank the new illuminant for making these discoveries possible. But a more substantial reward awaits it. Reduced prices and superior lights convey a certain moral to the gas consumer, and they reduce the profits of the purveyors as well. In these reduced profits may be found the electric light's opportunity. With the curtailment of extravagant dividends the obstacles attending the purchase or supercession of the gas interests will become less and less formidable, and those considerations which now hamper local boards in dealing with a much-desired competitor will gradually disappear.

A GUIDE TO PRACTICE IN THE SUBMARINE CABLE TESTING ROOM.

I.

The following papers are intended for the benefit of those who desire to learn the duties of an electrician more especially in connection with submarine cables. We take the beginner by the hand, as it were, and show him *seriatim* the various branches of the routine which he will have to follow, presenting the details of his work, as far as possible, in the order in which they will practically come before him.

Since every learner in almost all branches must be brought into relation with, and handle apparatus and objects which are at first altogether strange to him, he would only waste time by declining to use an instrument until he were thoroughly acquainted with all its parts and principles, much as that familiar genius is reported to have acted who would not bathe until he had learned to swim. On this ground we shall only give such explanations and descriptions of any point as appear to be necessary at the time, or such as a learner would be likely to receive in actual experience. It would not be desirable on teaching him his first test to delay him by giving an exhaustive explanation of the galvanometer, its construction, theory, varieties of form, &c. The student is urged, therefore, to study the best works extant on the subject for a more perfect knowledge of the theory, and for information which it would be mere repetition to produce in this place. Schwendler's and Kempe's books on testing, and Fleeming Jenkin on electricity and magnetism are particularly recommended to his attention.

The first thing a novice in testing is generally called upon to attempt is the measurement of conductive resistance by means of the Wheatstone bridge, and it is considered the easiest task that could be selected for making a beginning. The object as well as the theory of the test will be shown by and by, as in practice the student will certainly master the operation before properly understanding it.

We shall first notice the apparatus, instruments, and *adjuncta* that are open to observation in the testing room, and belonging to this branch of duty, and next call his attention to the various connections and matters outside, in the cable shop, and tank houses, which constitute the at present unseen portion of the arrangements necessary for carrying out this operation.

In the first place the Wheatstone bridge itself is pointed out, and if the student had never seen one before, but had possibly seen a theoretical representation as it is invariably given in all the treatises on electrical measurement, he would notice very little resemblance to the actual arrangement. Nevertheless, it is usual on introducing a novice to this test to give an outline of the operation, and, by way of explaining the theory, to draw a diagram in the diamond form so familiar to electrical students. The fact, however, that the illustration is so much unlike the real arrangement is apt to puzzle the beginner, and we think he obtains but a confused idea of the analogy. We shall presently produce this diagram when explaining the theory of the balance, at the same time giving a plan of the bridge board, and shall point how the two arrangements correspond, showing the advantage afforded by the theoretical illustration in assisting one to remember the connections, and how every separate portion should be placed. It is considered preferable to make our student familiar with the instrument as it exists in practice before entering on the other aspect of the operation.

The arrangements for the bridge are, of course, determinate—that is the relation of the several details to each other is the same, even where there is a difference of pattern; but we do not find the same pattern in all testing rooms. The best way of placing the apparatus (in our opinion at least) is on a board called the "Bridge Board," and containing the several parts of the whole set permanently fixed. The leading wires from piece to piece pass under this board or frame, through holes bored close to each, thus making the arrangement neater, and avoiding entanglement of leads otherwise likely to be in the way of the operator. Diagram, No. 1, which, for convenince of explanation, will appear in the next number, will give a useful form of Wheatstone bridge board.

It is necessary here to state that the conditions attending the testing of a cable at the works during manufacture differ in many respects from those which govern this operation in the case of a submarine cable after it has been submerged in the ocean. We call attention at this point to one only of these distinctions; thus, at the works we have both ends of the cable always under control, and can bring them together if necessary; whereas, of course, one end only is available after the submergence; the other is far out of reach.

There are, therefore, two points on the bridge board to which the two ends of the cable to be tested are connected. We say the two ends of the *cable*, but, strictly speaking, in some factories neither end, and in others one only, reaches as far as the testing room, and one end is *cable* end and the other is *core* end. A section of cable whilst being sheathed must be constantly recruited by adding lengths of core, which must pass through the sheathing machine; some portion, therefore, of each section not actually

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completed must be *core*, and is really not yet made into cable.

Inasmuch as it is necessary that the cable—that is, the sheathed or finished portion, and the core or unsheathed part—should be kept in separate tanks (of course, outside the testing room), connecting wires are joined to the *two* ends and lead into the room, where they represent and are practically regarded as the extremities of the true cable. But their conductive resistance is carefully taken into account, and is eliminated from the resistance of the cable. The length of this latter is accurately measured and rigidly noted.

We must consider the conducting wires or *leads* as separated into two portions, viz., that which belongs to and is within the testing room, and that reaching outside from the room to the cable tank. There will be two sets of these outside leads, one for cable and one for core. This is the arrangement for each machine. Each core and cable lead is, then, divided into two sections, separated by a small interval, which can be bridged over or joined up when required. There are many ways of doing this, though the object in all cases is to be able to vary the connections so that any one cable or portion of cable can be joined to a number of different wires inside the room. Every testing room, therefore, contains a large commutator or apparatus for making variable connections between cable or core in the tanks or cable shop outside and the leads and instruments inside. The number of variations to be arranged for depends generally on the number of cable-sheathing machines and cable tanks used in the works. The construction is simple, merely aiming at providing as many different diverging routes as possible for each point of junction of every cable or core lead. In a general way, each of these coming from the tanks is connected to a fixed standpoint, as a bar, and junction with different parts of this bar is afforded, so that leads can be taken from it in several directions, one at a time, of course. This can be most conveniently done by fixing the bars in question *perpendicularly* on the frame, care being taken that its supports are of good insulating material; holes are bored in it at intervals, and similar bars, also with holes, are fixed *horizontally* on insulating supports at each end, about half an inch distance from the first bars, so that the holes in both sets correspond. Every perpendicular cable bar, then, is crossed by several horizontal bars, which have each a lead attached. By putting a brass plug through the holes where one bar crosses the other, the result is to join the leads inside the room to the cable lead outside, its end being connected at the back of the frame. Besides these bar connections it is usual to provide separate terminals for making temporary junctions. They are generally in the form of a pillar, made of ebonite, a good insulator, surmounted by a brass binding screw by which any desired wire can be attached. The end of the cable or core lead is soldered inside the pillar to the lower part of the brass screw, so that the upper portion can be screwed down upon the lower, the two parts holding between them any leading wire that may be twisted round the screw thread. Thus no part of the cable lead is seen on the inside face of the commutator, but connection can be made inside as required. The bar arrangement previously mentioned is more useful for the control of the cables actually under process of sheathing on the machines; the ends of the *cable* leads are generally soldered to them, but the core leads are attached without soldering.

The battery for producing the current consists in the conductive or copper resistance test of but few cells—two, five, or ten. Sometimes these cells are arranged on or under the testing table. A separate battery room, however, is provided for general purposes, and the leads are brought in and permanently arranged as neatly and as much out of the way as possible.

The galvanometer is an important part of the apparatus necessary for the cable room test, and a separate instrument is always used where available; for the same degree of sensitiveness is not required as in the case of other tests. The choice, moreover, of a galvanometer for any particular purpose depends on the kind of wire or material that is to be tested. For many purposes a galvanometer with a pivoted needle answers very well; but for testing submarine cables, an astatic suspended mirror arrangement is always employed. For a description of galvanometers the student should consult the text books above mentioned. We may just say here that the sensitiveness of a galvanometer depends originally on the fineness or otherwise of the fibre suspending the little mirror carrying the magnets. The suspension, therefore, can be varied according to the degree that may be required.

Having now introduced the student to those parts of the testing arrangements necessary for the copper resistance test which he will find *inside* the room, he might be shown how the operation is performed. But we prefer to bring before his notice the various connections and proceedings *outside* in the cable shop, that he may have a comprehensive view of the whole operation and understand what he is really doing, and what is being done elsewhere at the same time in connection with that duty.

It will be understood that a long cable is necessarily sheathed in sections; many lengths are simultaneously made on separate machines. With some distinguishing points they are all alike, so much so, at any rate, that any reference here to one machine will serve for the whole number.

A submarine cable may be said generally to have two stages of manufacture, namely, as core and cable. We are not concerned here with the first of these, that is, with anything relating to its existence before it arrives in the cable shop to be sheathed. The operation of covering the conducting wire with its insulating coat or sheath is a speciality in all works. Great care is taken to keep secret the various conditions of the core making, and, in fact, this branch of the business is more interesting in a scientific point of view than the other departments of cable manufacture. The greatest care and best chemical and electrical knowledge is brought to bear on the preparation of the insulating material, and probably little, if anything, remains to be discovered in this direction.

We commence, then, with the core as it is delivered in the cable shop. Here it arrives wound on metal bobbins or drums, having previously undergone a series of tests both mechanical and electrical, so complete that the greater part of the work seems to have been done before it comes to our side. The first thing to be done is to turn it into *served* core. This means that it is covered with a service of jute, which is spun round its length as it passes through a machine carrying a series of bobbins full of the yarn. The drums are of various dimensions and contain different lengths, but the usual amount on each drum is one knot or nautical mile nearly. As the served core passes out of this machine it is carefully coiled in small tanks, from which it is led round pulleys or wheels conveniently arranged, and the end is brought down through a protecting wooden trough to the back of the cable machine on which it is to be sheathed. The other end of the served core is joined to one of the core leads above mentioned, which is connected up to the back of the commutator in the cable-testing room.

Before the drum or length of served core is allowed to enter the sheathing machine it is tested. After joining up to the machine it becomes, of course, a part of that section, and will be tested as a "machine" or as cable. The length entering the machine as served core emerges as cable, and is led to a cable tank, in which it is neatly coiled, the end (if not led direct to the room) being secured at the top, where it can always be got at without difficulty. Here, also, a lead is joined up to it which connects with the back of the testing room commutator.

This concludes a summary of the different parts of the arrangements relating to the bridge test of a cable which we find both inside and outside of the testing room. Of course other tests and matters are equally concerned, but the points noted are considered in relation to our immediate subject.

NEWCASTLE-ON-TYNE.—In connection with the University extension scheme here a series of twelve lectures will be commenced on October 5 by Mr. C. M. Thompson on "Electricity and Magnetism."

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SIR WILLIAM THOMSON'S POTENTIAL GALVANOMETER.

This instrument is shown in plan in Fig. I, and consists essentially of a coil of insulated copper or German silver wire, C, the resistance of which is generally over 5,000 ohms, fixed to one end of a platform, P, on which a magnetometer, *a*, rests. The magnetometer *a* is supported on three feet and a spring. Two of these feet slide in a V groove, cut in a slip of hard wood let into the top of the platform P, and this allows the magnetometer to be moved nearer to or farther from the coil, but prevents it being so turned-round as to change the zero reading of the instrument.

To set up the instrument for use, place it with the plane of the coil in the magnetic meridian, and level it by means of the screws S at the front of the platform. The plane of the coil is set in the magnetic meridian by turning the instrument until the index of the magnetometer points to zero on the scale. The platform is levelled by turning the screws S until the bubble of the circular level attached to the magnetometer stands in the centre of the level. The sensibility of the instrument is changed by changing the position of the magnetometer on the platform. When the front of the magnetometer is placed at any division of the scale marked on the platform the number stamped at that division indicates the deflection, in divisions of the magnetometer scale, produced by one volt difference of potential between the ends of the coil; the intensity of the magnetic field in which the magnetometer needles are placed being supposed unity. Two vertical white lines are put on the corners of the magnetometer at *a* and *a'*, so that, by using these as index marks, a subsidiary scale may easily be found on the side of the platform, according to which, with the actual magnetic field being used, the number of divisions deflection will be any simple multiple of the number of volts causing that deflection which the user of the instrument may find convenient.

In order to avoid as much as possible errors due to changes in the magnetic field produced by local influences, a permanent magnet, *m*, is supplied with each instrument, for the purpose of producing a field at the magnetometer needle much more intense than that of the earth. This magnet is placed in the magnetometer in the position shown in Fig. 1, and its field brought into parallelism with that of the earth by turning the screw S until the index points to zero. The absolute intensity of the magnetic field at the needle due to this magnet alone is carefully determined and marked on the magnet before the instrument is sent out. The total intensity of field is obtained by adding the horizontal component of the intensity of the earth's field to the number marked on the magnet. To avoid accidental demagnetisation of the magnet it must be kept at a distance from all other magnets.

In order to facilitate the use of the instrument a pair of flexible electrodes about four yards long are supplied along with it. These electrodes are furnished with terminal pieces of the form shown in Figs. 2 and 3. The terminal piece shown in Fig. 2 consists of two thin copper strips bent in the form shown in the figure, and insulated from each other by means of a thin piece of dry wood or ebonite. When the instrument is in use this terminal piece is pushed in between the spring terminals T attached to the coil. Fig. 3 represents a kind of spring clip found very convenient for putting the ends of the coil in electrical connection with any two points of a circuit. It consists of a thin strip of copper made to press against the side of a piece of wood by means of a rubber band. To prevent a current passing through the coil when no reading is being taken, a key, K, is placed between one end of the coil and the spring terminal T. This key should on no account be short-circuited, because the coil becomes heated, and consequently increased in resistance, when a continuous current is allowed to flow through, thus causing its indications to be too small.

To determine the difference of potential between two points of a circuit, an electrode is clipped in at each of the points, and then the key depressed, and the deflection noted. If the deflection be too great the magnetometer must be pushed to a division further from the coil, if too small, to a division nearer the coil. The number of divisions in the deflection is then to be multiplied by the number on the magnet, plus, say ·17 for the earth's force, and divided by the number at the division of the scale on the platform opposite the point of the magnetometer, the result is the difference of potential in volts. That is to say, the coefficient for volts corresponding to any division on the platform scale is obtained by dividing the intensity of the magnetic field by

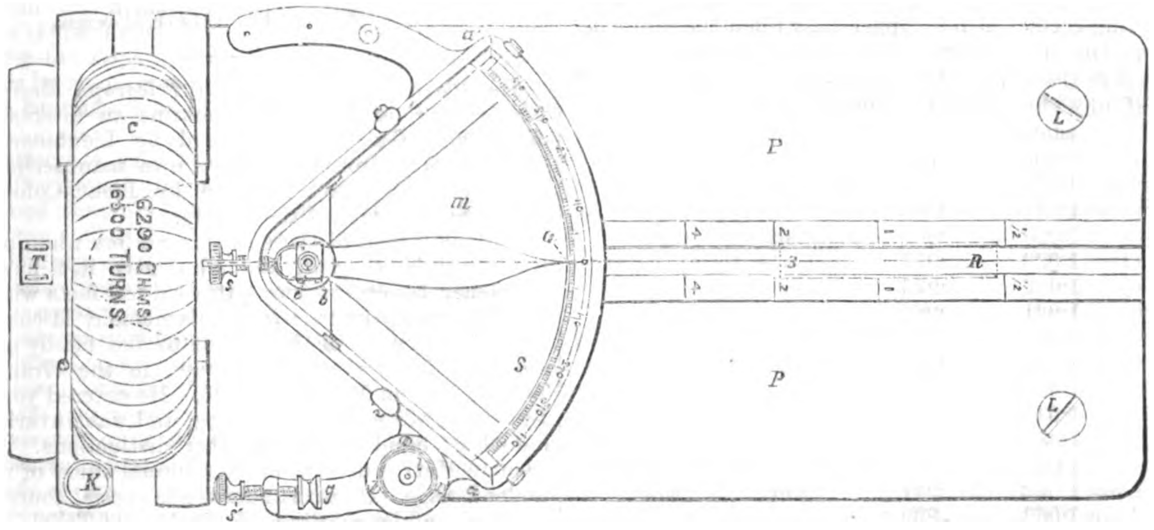
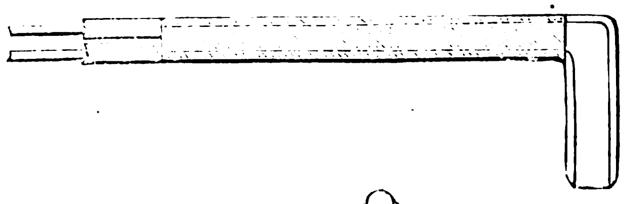


Fig. 1.

Fig. 2.



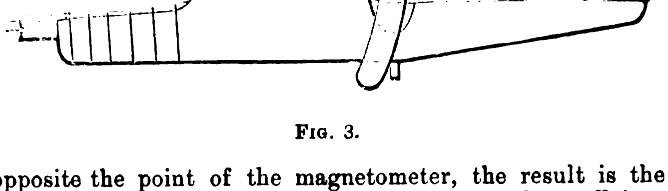


Fig. 3.

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the number at that division. When the difference of potential to be measured exceeds 200 volts the readings of deflection must be taken as quickly as possible on account of the rapid heating of the coil. The rise of temperature for any short time T may be taken as $v = \frac{E^2 T}{RJK}$ where E is the difference of potential and R the resistance in absolute measure, T the time in seconds, J Joule's mechanical equivalent of heat, and K the thermal capacity of the coil.

For example let $E = 200$ volts.
$R = 5{,}000$ ohms.
$T = 30$ seconds.
$J = 4{\cdot}2 \times 10^7$.
$K = 300$.

$$\text{Thus } v = \frac{200^2 \times 10^{16} \times 30}{5 \times 10^{12} \times 4{\cdot}2 \times 10^7 \times 300} = \frac{12}{63} \text{ or } {\cdot}9 \text{ or } 0^{\circ}{\cdot}19 \text{ C.}$$

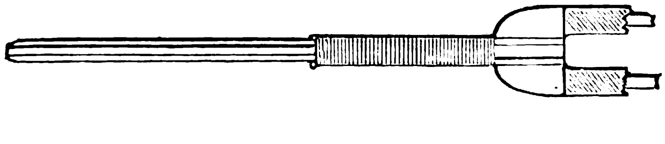
rise of temperature. The temperature of the coil at which the numbers on the platform scale are correct is stamped on the instrument. The following table gives the coefficients by which the deflections must be multiplied when the temperature of the coil differs by any number of degrees less than 20 from the temperature at which the instrument is correct. The first column gives the difference between the actual temperature and that at which the instrument is correct in degrees centigrade; the second column gives the corresponding coefficient for copper coils when the difference is positive; the third column gives the coefficient when the difference is negative; the fourth and fifth columns give the corresponding coefficients for German silver coils.

1	1·004	·996		
2	1·008	·992		
3	1·012	·988		
4	1·016	·984		
5	1·020	·980	1·002	·998
6	1·023	·977		
7	1·027	·973		
8	1·031	·969		
9	1·035	·965		
10	1·039	·961	1·004	·996
11	1·043	·957		
12	1·047	·953		
13	1·051	·949		
14	1·055	·945		
15	1·059	·941	1·007	·993
16	1·062	.938		
17	1·066	·934		
18	1·070	·930		
19	1·074	·926		
20	1·078	·922	1·009	·991

Current Galvanometer.

This instrument is similar in form to the potential galvanometer with the exception that the coil is made up of a few turns of thick copper strips and has a resistance of only about 1-1000th of an ohm. Any current the intensity of which is less than 200 amperes may be safely measured by this instrument. The numbers at any division of the scale on the platform indicate the deflection which an ampere of current produces when the magnetometer is set with its front edge at that division and the intensity of the magnetic field is unity. The mode of setting up this instrument for use is precisely the same as that described above for the potential galvanometer.

Fig. 4.



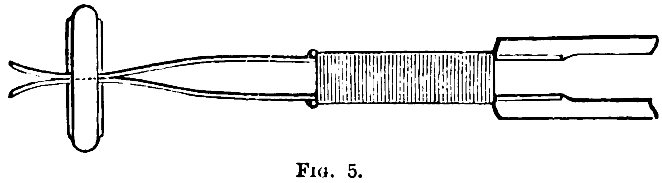


Fig. 5.

Terminal pieces of the form shown in Figs. 4 and 5 are attached to the coil of, and to the electrodes supplied with the instrument. When the electrodes are being removed from the coil or from the leads the two sides of the terminal piece, Fig. 5, should come into contact with each other before they are out of contact with the plates of the terminal pieces, Fig. 4. By attending to this the circuit is not interrupted and hence sparks are avoided. A separate terminal piece of the form Fig. 5 is also supplied for the purpose of allowing the galvanometer to be easily introduced or removed from the circuit. This terminal piece is made to form part of the circuit, the current through which is to be measured. By adopting this arrangement the galvanometer can be readily removed from one circuit to another.

The constants necessary for the graduation of these instruments in absolute measure were determined by Mr. Thomas Gray by methods which will be found fully described in *The Electrician* for July 8 and 22, 1882.

MICHAEL GLOESENER.

The *Journal of the Society of Telegraph Engineers and of Electricians* for September contains an interesting memoir of Michael Gloesener, compiled by Lieutenant V. H. P. Caillard, R.E., from Gloesener's own manuscripts, placed at Lieutenant Caillard's disposal by Lieut.-Colonel Webber, R.E., the president of the society.

For the benefit of those of our readers who do not possess the society's *Journal*, and who may not have heard of Gloesener before, we may extract a few facts with regard to his birth and parentage from this memoir. Michael Gloesener was related on his mother's side to the family of Nothomb, and was born at Haut-Charage, in the Grand Duchy of Luxemburg, on March 14, 1794. He entered young into the Imperial College of Luxemburg, and was invariably first in his class, besides gaining other distinctions. In 1816 he went to Metz, where he made a special study of mathematics under Lesage. He next underwent a special course of physics, and incidentally a course of theology at Trèves. Finally, in 1818, he entered the University of Liege. Here, whilst preparing for the diploma, at that time very rarely bestowed, of Mathesios Magister et Phil. Naturalis Doctor, he obtained in three successive years three gold medals—one for algebra, one for botany, and the third for chemistry. In the fourth year he was awarded a gold medal for a dissertation on electro-magnetism, but this medal he did not actually receive, out of respect, it appears, to Professor Vanderheyden (Professor Emeritus of the University of Liege, and chairman of the awarding jury), who pretended to see an act of insubordination in the fact that the competitor had maintained an opinion at variance with his own. From this time he devoted his researches more particularly to the science of electro-magnetism. His opinions on the subject remained unshaken, and he strongly supported the views of Ampère, from whom he had the consolation later on of receiving hearty encouragement as well as of seeing the theories which he sustained adopted as true by all men of science.

We have no space to refer to the interesting account of the riper years of his life contained in the memoir, and must pass on to an account of his electro-magnetic motor, which may well take a place in our list of historical machines. We may note, however, that Michael Gloesener passed away on the 10th June, 1876, at the ripe old age of 82.

On the 20th August, 1842, M. Gloesener forwarded to the Minister of the Interior of Belgium a paper describing his new invention, which was entitled, "A new system of electro-magnetic motors intended to replace steam engines, water engines, and motors of any sort whatever, and called the 'oscillatory electro-magnetic motor,' or shortly, 'oscillatory

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motor,' or still better, 'electro-magneto-oscillatory motor.'" In the covering letter accompanying this paper, M. Gloesener sets forth that he is forwarding a sealed packet containing the principles and scheme of a new motor system, capable of replacing other motors of whatever sort; and he asks for a patent, his end being, he says, "to secure to myself the priority of a discovery on which I am still engaged." He goes on to say that, although in the sealed packet sufficient details will be found, as to the construction of the machine, to enable a mechanician to execute it perfectly and without any trouble, yet he intended to send forward in a short time a still more elaborately developed plan, and, seeing that for the moment his only object in forwarding his paper was "to guarantee to himself the priority of the invention of the new motor," he asks that the sealed packet may not be opened until the further elaboration had been completed.

Passing on now to the paper itself, it may be as well to give the preamble in M. Gloesener's own words. "I have tried," he commences, "two different systems: that of direct rotation, and that of come-and-go (*va-et-vient*). This last system I call *electro-magnetic oscillatory*, because the throws of the beam (*les excursions du valancier*) are very small, or, electro-magneto oscillatory motor. Both theory and experiment have demonstrated to me that this latter system (the oscillatory system) is to be preferred, because the motive force developed by this system produces effects far more considerable than those obtained by the system of rotation. So far as I know, no oscillatory electro-magnetic engine, having the object of replacing steam or any other motive power by an electromotive force, has yet been suggested, and I have the right to consider as *new* that which I propose."

He then proceeds to explain the principles which had enabled him to invent and caused him to prefer the oscillatory system of electro-magnetic engines, and which, at the same time, serve sufficiently to indicate the method of construction of the proposed motor. They are as follow :—

1*st Principle.*—The action of an electro-magnet on a piece of soft iron in contact with it, and of the same electro-magnet on the same iron at different distances, is not governed by Newton's law, *i.e.*, is not in the inverse ratio of the *squares* of the distances. That reciprocal action decreases in a much more rapid ratio; so that, being very great at the time of contact, it is already quite small at only moderate distances, such, for instance, as from one to one and a-half inch. M. Gloesener made several experiments which he considered to prove that magnetic action decreases more rapidly than in the inverse ratio of the *cubes* of the distances, and to show that such decrease is greater when the distances are greater relatively to one another, and when the differences between the distances themselves are greater. Thus, the magnetic action at sensibly different distances follows no regular law dependent on those distances. From this ensues the following fundamental deduction: "That electro-magnets, both fixed and movable, should be made to act at distances as small as possible; in other words: If it be possible, movable electro-magnets should be made to oscillate by means of the influence of others which are fixed; this is only possible in a system of 'come-and-go,' and not in a system of direct rotation." The oscillatory movement could be changed into a rotary in the usual way practised in steam engines.

2*nd Principle.*—In the oscillatory or "come-and-go" system the forces of the fixed and movable electro-magnets not only act at small distances, but also in the same direction as the motion, and consequently with all their intensity. In the same system of direct rotation, on the other hand, the nearer the poles of the movable electro-magnets approach to the poles of the fixed electro-magnets the more oblique does their reciprocal action become. When they are at the smallest distances one from the other, *i.e.*, when their poles are exactly opposite, their reciprocal action is at its maximum, but is absolutely useless for producing any movement in the direction of rotation. Nay, that movement is, in fact, considerably impeded, as the action is then at right angles to the direction of rotation, which latter continues merely by virtue of the impetus already acquired. In the direct rotatory system the forces never act directly, but always obliquely, in the direction of the motion, as can easily be seen by the revolution of the forces along that line.

On the other hand, in the oscillatory system the greatest distance between the opposite poles which are attracting one another could only be a few lines (*quelques lignes*). (It should be well understood that this distance should always be made as small as possible, but large enough to be able to convert the oscillatory movement into one of rotation.) Take, for instance, a distance of three lines (*trois lignes*). At this distance the reciprocal action of two strong electro-magnets will be very great, and will also be in the direction of motion. This motion once begun, the attraction, and consequently the velocity, increase more and more up to the point of contact. At the instant of contact the polarity is changed (see below), and repulsion commences. The distance between the two electro-magnets having once more reached the extent of three lines, the polarity is again changed—*i.e.*, the attraction is substituted for repulsion—and thus, by means of the total reciprocal attraction, which always acts in the direction of motion, the oscillatory motion is set up.

3*rd Principle.*—The effect of the machine will be doubled if the fixed and movable electro-magnets be so arranged that when one end of the beam is attracted the other shall be repelled. The intensity of this action can again be doubled by causing each movable electro-magnet to oscillate between two fixed electro-magnets, as shown by accompanying figure.

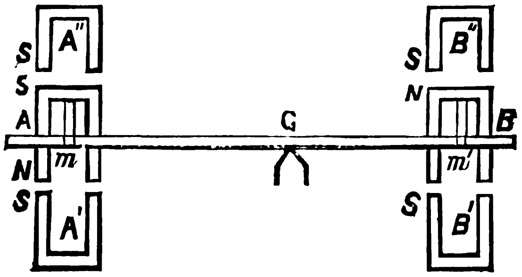

FIG. 1.

It will be seen that the beam oscillates about the fixed axis C, that the movable electro-magnet A is impelled towards the fixed electro-magnet A′ by reciprocal attraction, and repelled from A″ by reciprocal repulsion; at the same time the electro-magnet B is reciprocally attracted towards B″, and repelled from B′. The movable electro-magnets being fixed to the beam itself at *m* and *m′*, all the attractions and repulsions combine to produce the oscillation of the beam, and, these forces being exerted at very small distances, the movement of the latter will be extremely rapid and powerful.

4*th Principle.*—For simplicity, we have so far considered simple electro-magnets; but, practically, one magnet would be composed of numbers of others. A piece of very soft iron should be selected, one foot long, from one to two feet broad, and between four and five inches thick. Small trenches or channels should then be traced on it, about an inch and a-half deep, or deeper if the thickness should be greater, an inch broad, and with an interval of about an inch between them. In these trenches should be wound a very thick insulated conductor, or a fagot of copper wires, 30 or 36 in number, so that N and S poles should be alternately

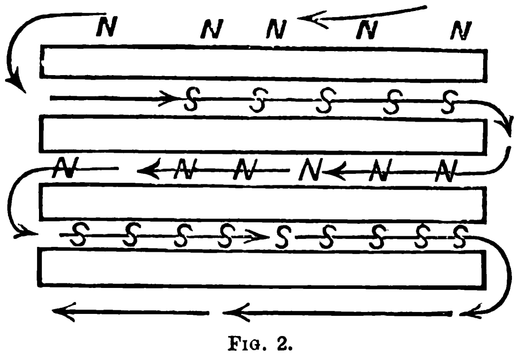

FIG. 2.

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formed as shown in Fig. 2. Experiment shows that the effect of such an electro-magnet is enormous.

The magnets (see Fig. 1) should be slightly inclined in order that at the moment of contact they may touch each other at all points. The movable electro-magnets should be lighter than the fixed, but of the same form, and rather longer or deeper, and so constructed that the poles and "channels" of the fixed and movable electro-magnets should correspond. (M. Gloesener here reserves to himself the right of employing and combining electro-magnets in such a manner as further experiment might show to be more advantageous, never, however, for an instant moving from his position of regarding the "electro-magneto oscillatory motion" as that to be preferred. He also reserves his choice of the electric conductor, and the particular mode of employing it.)

5th Principle.—Experiment proves, first, that when the current in an electro-magnet is stopped the magnetism developed still partly subsists, and, consequently, that that subsisting or residual magnetism must be an obstacle to the development of the opposite polarity. Secondly, that magnetism is not developed instantaneously, but only arrives at its maximum intensity after a certain sensible time. It follows, therefore, that this principle is established, that the direction of the electric current, or, in other words, the polarity, should be changed as seldom as possible in a second of time, but, nevertheless, often enough to give a sufficient velocity. Evidently the advantages resulting from these conditions are greater in an oscillatory system than in a system of direct rotation. For instance, in the oscillatory system, for one complete revolution the direction of the current must be changed twice; for ten revolutions per second, twenty times; for x revolutions $2x$ times, whatever may be the number of movable poles that one employs. But, in the direct rotation system, in order to complete one revolution, the current must be changed the same number of times as there are electro-magnets; and, since in order to procure any considerable force a sufficient number of electro-magnets must be used, it is evident, in reference to the point in question, that the oscillatory system is to be preferred. It will doubtless be observed that the two fixed electro-magnets on each side respectively of the beam, not only double (or nearly so) the resultant motion, but also the alternating poles in the beam itself arrive more readily at their maximum of development.

6th Principle.—The principle of changing the electric currents in the movable electro-magnets is as follows:—A commutator (*changeur*) is made by means of a copper disc divided into two parts, separated from one another by an insulating strip of dry wood, or better still, of glass. This disc is set rotating by means of a crank in connection with the beam. The commutator is placed on a horizontal axis fixed in the vertical plane of the beam, and its movements are regulated in such a way that the current changes direction each time that the movable electro-magnets come in contact with the fixed. Two copper studs rubbing against the commutator lead to it alternately the positive and negative electricity of the two poles of a voltaic pile.

7th Principle.—This principle treats of the multiplication of the electro-magnetic force, and of the velocity of the machine. If sufficient power were not obtained with a single beam, such as that which has just been described, two, three, or, in a word, a sufficient number, should be established in exactly the same way as has been laid down for one alone. M. Gloesener remarks that he does not consider it probable that more than two would ever be found necessary. As to the velocity, this, he says, on a railway, could be increased by giving a sufficient radius to the wheels; and the same thing should be done in all cases where it may be found necessary and feasible. Where a more moderate velocity suffices, the force may be increased by any of the usual mechanical means.

Such are the principles on which M. Gloesener proposed, so long ago as 1837, to construct his new motive engine. By means of them, he says, every one who is well acquainted with the electro-magnetic and magneto-electric phenomena will understand the way in which the new motor should be constructed, and could have one made, if he please, by any good mechanician.

THE ELECTROLYTIC COMPANY'S WORKS.

Within the last few months a new departure in electro-deposition has been made in London. We refer to the establishment which has been opened in Charlotte-street, Blackfriars-road, S.E., under the superintendence of Mr. W. Elmore, of 91, Blackfriars-road, the well-known introducer of nickel-plating on a commercial scale into this country, and the inventor of the Elmore dynamo-electric machine. The object of the Electrolytic Company which has opened the works in Charlotte-street is to perform every kind of electro-plating, from jewellery and small ware to hydraulic rams and gun carriages. It is becoming the custom now to nickel-plate the exposed iron surfaces of large machinery, such as the steam pipes of locomotives, and the cylinder covers of marine engines, as well as smaller articles, such as scissors, bicycle frames, saddlery, hardware, or cooking utensils. Nickel is both cheaper and harder than silver, while it does not tarnish like silver in the fumes of sulphuretted hydrogen. It is, moreover, almost as pretty to look at as silver; but, of course, for table services, including forks and spoons, the silver-plated article is preferred.

At present the works of the Electrolytic Company are not completed, but we found them sufficiently far advanced to repay our visit. In fact Mr. Elmore is already busy depositing all the usual metals, and can produce all kinds of plated ware. He has baths in operation depositing nickel, brass, copper, tin, silver, zinc, and gold.

The generators employed are the Elmore dynamo-electric machines, which are gradually superseding the Weston, Siemens, Schuckert, and others for this work, owing to their low internal resistance and powerful current. A 15in. Elmore machine is used for the deposition of all the metals we have mentioned simultaneously. It is capable of depositing 200lb. of pure copper per day on moulds of wax, and the current from it, as we have personally witnessed, will fuse a stout iron wire ¼in. thick in a very short time. A smaller type of the machine is also constructed and the current from it will produce a very powerful single arc light, or maintain 20 Swan lamps incandescent. A larger type than the 15in. is also constructed for electrotyping, and it will deposit 500lb. of pure copper on wax in a day, or a ton per week. In fact Mr. Elmore is now constructing ten of these machines for a firm in Swansea to deposit ten tons of pure copper a week for the preparation of electric conductors of low resistance, to be used in cables or electric lighting. The armature of Elmore's dynamo machine referred to consists of a soft iron disc set round with bobbins of wire on both sides and rotating between the poles of a number of electro magnets presented to it. These electro magnets and bobbins are all in one circuit, but the magnet coils are connected in multiple arc, so that the total internal resistance of the machine is small, and this fact gives it an advantage over other kinds of dynamos for the electro-deposition of metals. The coils can, however, be connected up in series, and high "tension" currents thus produced suitable for electric lighting. Mr. Elmore is, in fact, constructing machines for this purpose. At present, however, the chief demand for the machine has been for electrotyping, and we may mention that the Silvertown India Rubber Company are having them fitted up at their works for the deposition of copper on the carbons for electric lighting, and on certain parts of the Gramme machines made there. Messrs. Cassell, Petter, and Galpin, Messrs. Waterlow and Sons, and Messrs. De la Rue and Co., the well-known publishers, are also having these machines fitted up for electro-plating in connection with their art department. De la Rue and Co. have thirteen tanks in different rooms supplied from one machine specially constructed for the purpose, and employed in preparing the dies for the printing of postage stamps.

The machines employed at the electrolytic works are driven by two Otto silent gas engines, each of 12 horse-power. The current is conveyed to the tanks or depositing baths by stout rods of copper an inch or more in diameter, which run along the open mouths and serve to support the cross rods of copper from which the articles to be electro-plated are suspended.

The tanks are of various sizes, according to the character of the work to be done, but there are a number of large tanks 24ft. long by 6ft. deep, and about 3ft wide, which are employed for coating heavy articles. Such, for example, are the tanks where hydraulic rams are plated with hard copper. They are filled with a solution containing sulphate of copper, specially prepared by Mr. Elmore, in order to give a very smooth and regular surface, together with a dense and uniform layer. A sample of deposit in preparation for the Royal School of Mines was withdrawn from one of the tanks for our inspection, and the quality or surface and colour of the metal was beyond praise.

The process of coating an article consists in first polishing the

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rough casting on a revolving brush with crocus or oxide of iron and afterwards with rouge, which is a finer quality of oxide that floats when the crocus is put in water. The polished article is then plunged into a bath of potash and well scoured with pumice and rotten-stone to clean it from grease and dirt. It is then slid from this bath by means of a differential pulley and ceiling shaft to the tank, into which it is lowered and suspended. The strength of the solution is kept up by plates of copper hanging round the sides of the tank; and the liquid is kept in movement by means of a circular stirrer worked by a wheel gearing so as to prevent the solution getting denser at bottom and the deposit becoming thicker there. The strength of current is regulated by a zig-zag frame of copper rods at one end of the tank, to serve as resistance coils. Hydraulic rams can be covered in such a bath with a coat of hard copper 3-16in. thick. This is, however, reduced by turning to ⅛in. thick. The copper surface is as hard as iron, and does not oxidise, while it works more smoothly than an iron surface. Moreover, when the thickness is reduced, say 1-16in. by wear, it can be repaired again by a second deposit. Boiler tubes are also coated with copper, and turned to 1-16in. thickness in order to prevent the iron rusting in the boiler.

The solution employed by Mr. Elmore in the nickel plating tanks is the double sulphate of nickel and ammonia in water, fortified by nickel electrodes along the sides, each weighing ¾ cwt. Hot solutions of a peculiar kind are also used to deposit brass, copper, tin, and so on directly on iron, and Mr. Elmore showed us that this could be done almost instantaneously by plunging a piece of iron tubing in one bath after another. With the silver and gold baths an ingenious device is used by him to indicate when the required weight of precious metal is deposited on the article to be plated. It consists of a balance which weighs the article before it is coated, and can be set to indicate when it has reached the weight it ought to have. A contact is then made, and an electric bell rung to tell the foreman or overseer in his box, while, at the same time, the current from the machine of that particular bath is switched off. Altogether the arrangements of the Electrolytic Company are very complete and practical. Besides the electrotyping shops they have other departments where machines and plant are manufactured; and they have, no doubt, a useful career before them, as electroplating promises to become a very important industry. The large illustration represents a plating room with the various tanks fed by an Elmore machine.

LIGHTNING CONDUCTORS.

The following rules for the erection of lightning conductors, based upon the recently published report of the Lightning Rod Conference, have been recently issued by the Explosives Department of the Home Office to the occupiers of all factories and magazines for explosives, and to those local and police authorities upon whom devolves the inspection of stores of explosives.

1. Material of Rod.—Copper, weighing not less than 6oz. per foot run, the electrical conductivity of which is not less than 90 per cent. of that of pure copper, either in the form of rod, tape, or rope of stout wires, no individual wire being less than No. 12 B.W.G. (·109″). Iron may be used, but should not weigh less than 2¼lb. per foot run.

2. Joints.—Every joint, besides being well cleaned and screwed, scarfed, or riveted, should be thoroughly soldered.

3. Form of Points.—The point of the upper terminal of the conducter (that portion between the top of the edifice and the point of the conductor) should not have a sharper angle than 90deg. A foot below the extreme point a copper ring should be screwed and soldered on to the upper terminal, in which ring should be fixed three or four sharp copper points, each about six inches long. It is desirable that these points should be so platinised, gilded, or nickel-plated, as to resist oxidation.

4. Number and Height of Upper Terminals.—The number of conductors or upper terminals required will depend upon the size of the building, the material of which it is constructed, and the comparative height above ground of the several parts. No general rule can be given for this, except that it may be assumed that the space protected by a conductor is, as a rule, a cone, the radius of whose base is equal to the height of the conductor from the ground.

5. Curvature.—The rod should not be bent abruptly round sharp corners. In no case should the length of a curve be more than half as long again as its chord. A hole should be drilled in string courses or other projecting masonry, when possible, to allow the rod to pass freely through it.

6. Insulators.—The conductor should not be kept from the building by glass or other insulators, but attached to it by fastenings of the same metal as the conductor itself is composed of.

7. Fixing.—Conductors should preferentially be taken down the side of the building which is most exposed to rain. They should be held firmly, but the holdfasts should not be driven in so tightly as to pinch the conductor or prevent contraction and expansion due to change of temperature.

8. Other Metal Work.—All metallic spouts, gutters, iron doors, and other masses of metal about the building should be electrically connected with the conductor.

9. Earth Connection.—It is most desirable that, whenever possible, the lower extremity of the conductor should be buried in permanently damp soil. Hence, proximity to rain-water pipes and to drains or other water is desirable. It is a very good plan to bifurcate the conductor close below the surface of the ground, and to adopt two of the following methods for securing the escape of the lightning into the earth—(1) A strip of copper tape may be led from the bottom of the rod to a gas or water main (not merely to a leaden pipe) if such exist near enough, and be soldered to it; (2) a tape may be soldered to a sheet of copper, 3ft. by 3ft. by 1-16in. thick, buried in permanently wet earth and surrounded by cinders or coke; (3) many yards of copper tape may be laid in a trench filled with coke, having not less than 18 square feet of copper exposed.

10. Protection from Theft, &c.—In cases where there is any likelihood of the copper being stolen or injured it should be protected by being enclosed in an iron gas pipe reaching 10ft. (if there is room) above ground and some distance into the ground.

11. Painting.—Iron conductors, galvanised or not, should be painted. It is optional with copper ones.

12. Inspection.—When the conductor is finally fixed it should in all cases be examined and tested by a qualified person, and this should be done in the case of new buildings after all work on them is finished.

Periodical examination and testing, should opportunities offer, are also very desirable, especially when iron earth connections are employed.

THE JABLOCHKOFF ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of the shareholders of this Company was held at the City Terminus Hotel on the 15th inst. for the purpose of considering, and, if thought fit, passing the following special resolution:—"That the Articles of Association be, and the same are hereby, altered as follows:—1. By the omission of Articles 16, 20, and 31. 2. By the omission of the following words 'and the dividends (if any) forfeited therewith' from Article 32. 3. By the omission of the word 'meeting' between the words 'such' and 'to' in Article 48, and the insertion of the words 'business shall be given' instead thereof." Mr. James Wilson, M. Inst. C.E., presided.

The Secretary (Mr. Francis R. Reeves) read the notice convening the meeting.

The Chairman stated that one of the objects of the directors in calling the shareholders together on that occasion was to inform them that they had made an application to the Stock Exchange for a special settlement in the shares of the Company. The Committee of the Stock Exchange had required certain alterations to be made first in their Articles of Association, and the board considered that the alterations were of a very unimportant character. He then proceeded to explain in detail the nature of the alterations, and with regard to their effect stated that they would give the shareholders more power and the directors less. Supposing they were agreed to the Stock Exchange would grant the Company a settlement without waiting for the formal confirmation required by the Act. In answer to a question, he added that it was a settlement and not a quotation which would be granted. He then moved the resolution as above.

Mr. Siegfried Simon (shareholder) seconded the motion, which was carried unanimously.

The statutory general meeting of the Company was then held, and

The Secretary having read the notice convening the meeting,

The Chairman said: You are aware that this is our first or statutory meeting, which we are obliged by the Act of Parliament to hold within four months after the formation of the Company. In so short a time we cannot have done so very much, and therefore I have not much to tell you. I may remind you that this Company was formed with a nominal capital of £300,000, that we were able to obtain from the general public support amounting in all to 400 shares about half the capital, and we have found that we could employ, from the numerous demands on us for our lighting, the whole of our capital could we have got it. As soon as possible after the Company was formed we took offices at a moderate rent at No. 1, Great Winchester-street-buildings. We have appointed managers thoroughly acquainted with the enterprise we have started, and I am glad to say that we have had numerous inquiries, besides from our regular customers, from harbour commissioners, docks, theatres, and private dwellings—in fact, demands so great that we have had a difficulty in the time of fulfilling all the requirements made on us. As you see, we have applied for a settlement on the Stock Exchange, and now you have passed this resolution we shall get it, and that will help us considerably in our proceedings. We have also appointed canvassers who are paid according to results. They are working in various parts of London as well as in the northern parts of England and in Scotland. We had to wait for some time to see what the Electric Light Bill would call on us to perform, and I need not tell those acquainted with the subject that this matter has

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given us a great deal of difficulty. We hardly knew what to do in the matter, but we have made applications to the vestries of London and all the various local authorities to give us permission to lay our wires in different parts, so that we can supply any one, as a gas or water company does. The Act specifies that before the Board of Trade will give us permission to lay any wires we must obtain the permission of all the local authorities, and the vested interests of a great many people living in the parishes are strongly opposed in many cases to any improvement. We hope to get over that, however, and, in fact, we feel sure that electrical science is not going to stand still for the sake of any vested interests, gas or otherwise. As for the details of the business we have in hand, you will excuse me if I am not too detailed on that. You know we are a strictly competitive company. There are numerous other companies volunteering for nothing almost to light up different places, and it would not do for us to tell you the means of defence we have in our operations. You must leave that to a future time, when I hope we shall have some good results to show you. We are forming lighting centres in different parts of London, and I hope at the next meeting to tell you that we are very progressive in that respect. As we say in our prospectus, the Board of Works have prolonged our contract for lighting the Thames Embankment, and they have now given us permission to erect a much larger building on the Thames Embankment, having even supplied us with drawings and details, so that we can have larger engine power there and supply a greater amount of the electric light. We have taken a building also on the Albert Embankment for the purpose of making our own candles—these which you see here (on the table). That forms the Jablochkoff electric light, and nothing can exceed its simplicity when compared with other lights. There is no machinery of any kind whatever. In all other electric lights there is machinery—some of it very complicated indeed—which must certainly sooner or later get out of order. Others not worked by machinery fall by gravity as the consumption goes on, but the Jablochkoff light burns as a common wax candle. Once lighted it burns to the end; there is no machinery connected with it, nor has gravity anything to do with it. The consequence will be that its simplicity must in the end, as in the past, obtain much more custom. These candles are obtained—the same as the French company obtained them—from another company, who make them in France, and a great profit is derived from their manufacture and sale. They used to cost 7d. each and now they cost 2d., and you get a profit on that, but we hope, by making them ourselves, greatly to reduce the price, and to have an equal profit, or more than we have now. In those premises on the Albert Embankment we purpose laying down some machinery and making those candles ourselves, and we believe we shall make a tremendous reduction in our present rate, and make them better, and we hope not only to supply them to our own customers, but also to the French Company, who buy them from the other company in France. The beauty of the Jablochkoff light is this—there being no machinery attached to it, it can be worked from a great distance with greater certainty. From a mile to a mile and a half the lights are as certain to burn as if they were close by. No one need watch them. In all other lights where there is machinery, besides the profits they get on the installation of any new light—which we get also—they have the profit on the sale of a lamp; but once having sold that lamp, there is an end to all their profit whatever. No profit comes to any of those companies until a new lamp is required, but in our case a profit will come from the daily consumption of these candles. I hope before long that we shall have so arranged our works that we shall be able to supply our candles to our customers, and also to the French company, if we can supply them at a little less rate than they get them now. Since the formation of the Company, Mr. Jablochkoff, a celebrated electrician, has been over to this country with a new patent motor, which we succeeded in purchasing from him, after taking the advice of our electrician, Mr. Sabine, who said it was one of the most wonderful things he had ever seen. This motor will be able to drive any small machine by electricity, whether generated by a steam engine or a battery. It is also in itself a generator of electricity, and can be constructed at such a very small sum, compared with the generality of dynamo machines, that we hope when once we succeed in getting the machines over from France, and are shown how to make them ourselves, we shall be able to supply the electric light companies and consumers with a dynamo machine at a very great reduction on the price they now pay. More about this I cannot say now. We have ordered three of these machines over from France, and I hope we shall be able later on to tell you of our great success. Something has been said by different papers of the difficulty in using the incandescent light in conjunction with the Jablochkoff light; but I have to-day seen an incandescent light used and mixed up with the Jablochkoff arc light, and they perform very well together indeed; and I am glad, therefore, to say that I think the difficulty prognosticated as to that is at an end. I do not know that I have anything more to tell you, but I hope at the next meeting to be able to report something more satisfactory to you. We are doing our best for you.

Mr. SHERIDAN inquired what steps the directors were taking for manufacturing the candles.

The CHAIRMAN stated that they had taken the works referred to on the Albert Embankment, which were admirably situated for the purpose, and they were now entering into contracts for the different small works and machinery.

Mr. SIMON asked if any one else could manufacture the candles.

The CHAIRMAN: No; that is the beauty of our enterprise—that no one can make them but ourselves. We have no licenses to pay. We have bought the sole right for England and the colonies.

Mr. LYNDALL stated that some suggestion was made in the prospectus as to the probability of selling some of the concessions to other companies, and he desired to know if there was any probability of that being done. He also asked if the amount of capital required by the Stock Exchange had been subscribed.

The CHAIRMAN: Not for a quotation. They had about half the capital subscribed, two-thirds being required. In reply to other questions the chairman added:—A statement did appear some time since in the papers, without our knowledge or consent, stating that we were favouring subsidiary companies. There was some truth in the statement. There was an offer made for forming a company in the North of England and Scotland, but the directors do not think the time has arrived for that. We think we had better work the light ourselves for the present; but when the proper time comes we may grant powers for small towns and parishes, but not to a great extent. As for lighting the Strand, we are making arrangements at this moment for doing that—in fact I think I may tell you that we have made arrangements with the Gaiety Restaurant, and are getting our plant in order to do that. I may tell you another fact. One of our largest shareholders is a gentleman who has used the light for between two and three years, and as soon as he heard that this Company was going to be formed—it was at the first meeting of the directors—he made an application for shares to the extent of £5,000. He has used the light for some time, as have other of our customers; but they have been induced to use other lights when wanting additions. Other companies have been led to supply this work almost for nothing; but, notwithstanding, our customers have found it advisable to give those other systems up and come back to us. In two large cases where that was done they have nothing but the Jablockkoff light. I have seen this morning at Mr. Whiteley's the incandescent light used in conjunction with the arc light on the same circuit. They seemed perfectly satisfied with it, but no doubt some improvement will be made in it day by day. These, however, are actual facts, not theories.

Mr. SIMON: Have you made any profit on lighting up the Embankment?

The CHAIRMAN: As to that I must not say too much. We do not light the Embankment for nothing. We did light one place for nothing, but we have given notice that we shall do so no longer. That is the underground station at Charing Cross.

Mr. SIMON thought the shareholders might be misled by the statement in the prospectus that an extension had been obtained from the Board of Works of the contract for lighting the Thames Embankment. This was of no good unless a profit was derived from it.

The CHAIRMAN: We believe we do not lose by it. It pays for itself. The underground station at Charing Cross we have been lighting for nothing, as the French company did the same, but we have now given notice to the District Railway Company that we shall do so no longer. We have offered to light that station at the same rate as for gas, and as they do not seem inclined to consent to that we have given notice to cease the lighting.

A SHAREHOLDER inquired if the previous company had been merged in this Company.

The CHAIRMAN: That company has ceased altogether. We have bought their rights for England and the colonies. By the new contract we have with the Board of Works, they are going to extend the whole of their lighting, and that will give us an increased price. A French company was working on the Jablochkoff system in France, but they could not work in England.

Mr. TERRY thought that as far as they had gone they should be satisfied. Time must be allowed for the development of their working.

Mr. STEINTHALL stated that other companies were occupying the ground in the provinces with their systems, in connection with subsidiary companies. He thought their own working would probably be conducted more effectively from their central office by means of such organisations.

Mr. DAVISON asked what prospect there was of the Company being able to obtain a quotation. He further inquired if any promotion money was paid, the proportion of the present capital held by the board, and their remuneration.

The CHAIRMAN: You find all that information in the prospectus. As to the purchase price, and as to the remuneration of the directors, and so forth, that is in the Articles of Association, which the shareholders can obtain for one shilling. We do not think the time yet opportune for the formation of subsidiary companies. Had our Company been brought before the public one week before it was there is no doubt that we should have had the whole of our capital subscribed, but there came a revulsion of feeling. The general public became mystified as to the merits of the different lights, and suddenly the applications ceased. Since then I do not think there has been a time at which you could properly attempt to form subsidiary companies. In all these cases it would not do to fail, and we have no wish to throw any expense on the Company. At the present time, certainly, no one in the provinces would take on themselves the speculation of forming any subsidiary company.

A long discussion followed as to the appointment of an auditor—an office which the directors had left to the shareholders to fill up. In the result, Mr. Roderick Mackay was appointed, at a remuneration of twenty-five guineas.

On the motion of Mr. TERRY, seconded by Mr. PRATT, a vote of thanks was passed to the chairman and directors, and

The CHAIRMAN having acknowledged the compliment, the proceedings terminated.

DIRECT SPANISH TELEGRAPH COMPANY.

Report of the directors for the half year ended 30th June, 1882, to be presented at the general meeting of shareholders, to be held on Friday, 29th September, 1882. The annexed accounts for the half year ended 30th June, 1882, show a balance to the credit of profit and loss of £5,889 12s. The receipts were £1,075 12s. 3d. in excess of those for any previous half year since the formation of the Company. The Bilbao cable was interrupted twenty days during last half year, from 30th April to 19th May. The repairs were very promptly executed and the cable has since been in excellent working order. The cost of the repairs, £2,814 9s. 4d., has been paid out of the revenue of the half year. The Marseilles-Barcelona cable remained in excellent working order throughout the half year, and continues so. To meet a considerable accession of business, new offices have been engaged in Leadenhall-street, and will be ready for occupation shortly. The payment of the dividend on the preference shares absorbs £2,921 10s., leaving £2,968 2s., out of which it is proposed to declare a dividend of 3s. per share, free of income-tax, on the ordinary shares, and to add £800 to the reserve fund, which will then amount to £6,000, leaving a balance of £228 9s., which it is proposed to devote to the reduction of the preliminary expenses account. The dividend warrants will be issued as soon as remittances from Spain for the balance of the telegraph accounts to 30th June last are received.

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THE SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).

The statutory general meeting of the shareholders of this Company was held on the 19th inst. at the City Terminus Hotel, under the presidency of Mr. James Staats Forbes.

The SECRETARY (Mr. J. H. Ivory) having read the notice convening the meeting,

The CHAIRMAN stated that that was the statutory meeting, called according to the Articles of Association within four months of the launching of the Company, but not for the purpose of submitting any report or accounts or passing any resolution. In introducing the directors to them, he called attention to the fact that Mr. Swan was among their number, and stated that the little he had had to do with that gentleman had satisfied him that he possessed the attributes not only of a man of genius but also those of a man of business. They were also fortunate in having secured the services of another very eminent man, Mr. Crompton, and he (the chairman) need hardly tell them that whatever confidence they might be pleased to repose in the board of directors, the real question was whether they had or had not acted wisely in having backed Mr. Swan and Mr. Crompton, because on the knowledge and devotion of those gentlemen must really depend the success of the Company. It was, of course, very early days to enlarge on that topic. There had been a kind of electric light fever. Every one knew that during the past few months a great number of companies had been started, and a great number of predictions had been made. They believed, as far as this Company was concerned, that the Swan lamp was a sound, practical thing, with a great future. He should not, however, indulge in prophecy, but any one could satisfy himself as to the Swan lamp by going to certain exhibitions and other places where it was to be seen. They might see it as well as anywhere, he thought, at the Savoy Theatre, where they would see its beautiful softness, and experience its soothing effect on the eyes and the benefits of the very low temperature which it caused. It could be seen in many other places. Everything seemed to point to this—that they were possessed of the means of producing a light applicable to every kind of thing—to street lighting, if need be, great public buildings, theatres, halls of all kinds, manufactories, coal mines, and steamers. He had had a little to do with a rather interesting steamer which had just been launched, the "Invicta," which was now running between Calais and Dover, and he could assure them that not the very least of her merits was the fact that she was lighted with the Swan light. The light was also either used on, or being fitted to, a great number of ships of some of the principal lines—among others, the Orient and the Union. In fact, the application of the light to almost every purpose ashore or afloat seemed only a question of time. Since the formation of the Company four months ago, they had had a good deal of work to do. They had bought the Swan Company as a going concern, with their foreign patents. They had also made an arrangement with Mr. Crompton, under which what were called installations—the machinery necessary for providing the light, both the arc and the Swan—in different places had to be taken over in virtue of the purchase. That had all been done, and he was glad to tell them that the factories in which the lamps were produced were in admirable working order. They found everything there which they had contracted to buy in proper condition. Some little time was, of course, involved in the transfer. They had also had to consider the extension of their business, and without wishing to make any great flourish of trumpets, he thought he might say generally, that so far the progress of the concern had been very satisfactory. Of course, being a new thing they had had great difficulties to contend with. There were a great many systems now bidding for public favour—the Brush, the Edison, and other lights; but they in this Company felt that whatever the differences between one invention and another, the scope for their exercise was so wide that there ought to be no jealousy. In fact there was quite enough for every one to do to carry out this new and beautiful invention. The directors were not insensible to what was going on around them. They had had to watch with some care rather important legislation. It was not felt politic or wise to make any very great display, or urge forward the business with much advertising while Parliament were making up their minds as to what the position of the electric light companies was to be in the future, and they had practically only just passed a particular Act, which regulated the position which these companies were to fill in the future with respect to the public service. The Board of Trade happily, he thought, took the initiative, and that would probably prevent the electric light companies from falling into some of the errors and extravagancies which railway and gas and water companies fell into. Certain general principles had been laid down as to the use of the electric light for public purposes, and those who were practically acquainted with the matter were perfectly satisfied that if they were patient, and developed their invention prudently and cautiously, and as men of business, they had a very good future before them. They hoped between now and the end of their first business year to be enabled to produce a statement of accounts, working expenses, revenue, &c., which would be more or less satisfactory. There was no reason to believe it would not be entirely satisfactory, but he would almost warn them not to be "carried away" as it were by the belief that an enterprise of this sort, or any electrical enterprise, was at once to launch out into very great and brilliant profits on its mere business. Some of the companies had obtained very large sums by selling concessions to affiliated companies. That was a very legitimate source of profit, open to this company as to others, but, of course, the real basis of the prosperity of a company like this must be in the profit realised in the daily business—the difference, in fact, between what they received for supplying the article and what it cost them to produce it. As far as their experience went he thought they need have no fear on that ground, that the light itself would justify such a charge to the public between the cost of its production and the charge for its consumption as would leave a very fair, indeed, a very good interest on their capital. They had not only bought the Swan light itself, and the privileges attaching to its manufacture in the United Kingdom and, indeed, generally throughout Europe and the colonies, but they had one or two other things. Every one had heard a great deal lately about the Faure accumulator, and Mr. Swan had some invention in connection with an accumulator, as had also Mr. Sellon. Just the same as with the lamp, there was a strong family resemblance between all these accumulators; and it was the good fortune of this Company to be in possession, through an agreement entered into between Mr. Swan and Mr. Sellon, and as part of the assignment to them for value received, of an accumulator, and the power to manufacture and use accumulators, which they believed would be of the greatest value to this Company. He did not say more about that than merely to indicate to them one source of profit. On the Brighton Railway might be seen the practical application of the accumulator and the lamp, where a train in starting was supplied with a certain amount of electricity, and was enabled on the journey to keep that supply up, and, in fact, light itself from one end of a long journey to another at a very moderate cost—somewhere within the cost of gas. That, in itself, was an indication of what this system might come to, because if they could supply all the railways existing, as he felt satisfied would be the case sooner or later with the electric light—either the Swan, the Edison, or some other—they could see what an outlet there was there for business. As to the various systems, they had no preferences or antagonisms. The rule they had laid down for themselves was that, having what they believed to be a perfectly practical and beautiful invention, studiously to find out the way and apply it in the manner most advantageous for the purpose. He should be glad to answer any general questions, while Mr. Swan or Mr. Crompton would reply to any of a scientific nature; but he did not think he ought to conclude without referring to one other subject. They might have seen that there had been some process instituted against the Company by the Edison Company for some infringement. The directors were not very seriously alarmed about this. The Edison Company were a highly respectable body of people, with, no doubt, the invention of a very distinguished man; and he himself thought it was a very happy circumstance that there should be men like Mr. Edison in one hemisphere, and Mr. Swan in the other working for the advantage of mankind, and that they should hit on an invention allied in kind if not precisely the same in fact; but they looked on the "move" of the Edison Company as merely political. They did not think seriously that there could be any doubt of the entire safety of Mr. Swan's invention. Every one knew it was matter of public notoriety—that long before Mr. Edison was heard of Mr. Swan had lectured on and had exhibited his lamp. They had no fear of the Edison Company either for this reason, that the field was so enormously wide that no particular body of men, or no particular inventor, could possibly hope ever to cover it or monopolise it for himself. He thought it very likely that they might see, in respect to the Edison and the Swan companies, a similar arrangement to that which took place between the Edison and the Bell companies in the telephone. The cases were almost identical. After litigation, or the threat of litigation, on either side, the common sense of the shareholders and the directors induced both parties to do what had been of such immense advantage—effect a union with each other instead of fighting each other; and, as he had said, he believed the same thing would happen with the Edison and the Swan Electric Light companies. It was rather fortunate that some of the people connected with the two companies were also interested in the Edison telephone and the Bell telephone. This Company, at all events, did not wish to have litigation. They would prefer to go on peacefully and to do what they could by honourable, straightforward, and legitimate competition with the other companies, being perfectly satisfied that to meet the growing wants of the public in this direction their full powers would be taxed. He then invited any shareholder who desired further enlightenment to ask questions; but, no one rising to address the meeting, he stated that they would prosecute their business in the best way they could, and that in the course of about eight months, or within a year at all events, the shareholders would be called together again, when a report and statement of accounts would be submitted to them. He only hoped when the time came that they would have made some substantial progress, but if they failed it would certainly not be through any want of exertion on their part. He ought to have referred before to the presence of Mr. Stern, who had been associated with Mr. Swan in the perfection of his most beautiful instrument. Though the lamp bore the name of Mr. Swan, he believed that that gentleman would be the first to accord to Mr. Stern a share of the inventive faculty and patient power which had been necessary to develop what now appeared so simple a thing that it could be bought for five shillings.

A vote of thanks was then passed to the chairman and directors, and in reply

The CHAIRMAN expressed the acknowledgements of the board for the confidence reposed in them, and stated that they would do their best to merit it.

The proceedings then terminated.

BIRMINGHAM & WARWICKSHIRE (BRUSH) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

The statutory general meeting of this Company was held on the 15th inst., at the Cannon-street Hotel, under the presidency of Mr. George Felton.

The SECRETARY (Mr. H. W. Atkins) having read the notice convening the meeting,

The CHAIRMAN said: Under our Articles of Association, and by Act of Parliament, it is incumbent on us to meet the shareholders within four months of the registration of the Articles of Association. We have done that on this occasion, but, like most of the electric light companies, we have been unable to execute much business during the first three months; indeed, it has been our work to lay, as far as possible, plans for the future. Those plans, as far as I am able to do, I will place before you now as frankly and as candidly as I know how to. When this Company was formed for Birmingham and Warwickshire, we found it was necessary that we should have, as far as possible, the surrounding districts, inasmuch as part of the borough of Birmingham—Birmingham having grown, like most other places—is not in the county of Warwick. Just at that time the opportunity occurred of purchasing a concession for Stafford and Worcester. We did that at a cost of £26,000, first consulting our solicitor whether we had power to do so. At that time that was considered a very good bargain. I still think it a very good bargain, as I believe do my co-directors, inasmuch as, at Stafford particularly, we hope to have a large mining business. With the Worcester concession was turned over to us a contract entered into by Mr. Hammond with the directors of the

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Worcester Exhibition. That we considered would be an opportunity for us to advertise the light in that particular district, and we have taken it over. We are now lighting the Worcester Exhibition, and have been doing so for the last two months. The whole contract is for four months. The Worcester Exhibition directors have since then given us an order for lighting a horticultural exhibition, so they appear to be very well satisfied with the light in that district. In addition to that we have had a large firm in the neighbourhood of Birmingham applying to us for our system of electric lighting. They have been at Worcester, and the manager expressed such satisfaction with the light which he saw there, that I was in hopes I should be able to-day to place before you the agreement signed with the firm, but it appears that the legal gentleman connected with them is absent on his holidays, and we have been unable to get it signed. He then read a letter from the manager of the firm stating that the whole matter was settled, subject to the advice of the solicitor of the firm. Continuing, he said: In addition to that we have had negotiations with Coventry, Burton-on-Trent, Rugby, and one or two other towns in our district, Kidderminster in particular. At Kidderminster it so happens that they have three or four streets which are worth lighting with the electric light; but the remainder the town council came to the conclusion should only be lighted with gas. The gas company, however, acting under such circumstances as I suppose they should, determined that, unless the town council gave them the whole of the lighting, they would not light the sub-streets. Therefore, that matter fell through for the present, the contract with the gas company, however, being renewed for one year only. With regard to Burton-on-Trent the town council have obtained an Act of Parliament enabling themselves to put up the electric light in the town, but we are in negotiation with them, and I hope—and I think there is every probability of it—that we shall be the contractors for carrying that out. If so, it will be as remunerative to us as if we put up the light ourselves. Taking all these things into consideration, I think you will see we have done as much as could be done in three months. We have actually been lighting the Worcester Exhibition for two months; we have already settled with one of the largest firms near Birmingham for the lighting of their manufactories, and we are in negotiation with four or five of the towns in our district. I therefore hope you will come to the conclusion that your directors and managers have not been idle during the time we have been a company. As to the future, no doubt when the Company was started, as was said the other day, the electric light was on the crest of a very high wave. Things looked well, but though they do not look so well now, according to some of the newspapers, I believe for my own part that there is a future for the electric light. I have had the opportunity of seeing the electric light under very nearly every circumstance, I have also had opportunites of seeing nearly every system of electric light, and have come to the conclusion that the one we have is as good or perhaps better than any other, for street lighting particularly. We are now putting up an incandescent light for house lighting, which I think will be as good as the large arc lamp we have out-doors for street lighting. It is very difficult to say what will be the profit on electric lighting. We hear chairmen of gas companies say it is impossible that the electric light can ever compete with gas in the matter of price. Well, now, in opposition to that, we have a right, I think, to take into consideration statements made by people who are working the electric light themselves—not companies, but private individuals, who have come to the conclusion that they can get a very much better and purer light at a cheaper cost than they can the gas light; and it is cheerful, I think, when we look at the report of Lieut.-Colonel Festing, the director of the South Kensington Exhibition. He has put the whole matter to the test for 12 months in lighting the South Kensington Exhibition. He has had a machine put up there, and has contrasted the price which the electric light has cost during the 12 months as compared with gas. We all know that the electric light is very far superior to any gas for fine art exhibitions, such as at South Kensington. We know the deteriorating effects of gas on valuable paintings, and indeed in some galleries they refuse to have gas. But we find, as to price, that Lieut.-Colonel Festing says he has saved during the year something like £725 in lighting the South Kensington Museum. Now, here we have an independent testimony outside the electric light companies, outside gas companies, or I may say outside any influence that could be possibly brought to bear on a gentleman occupying the position that Lieut.-Colonel Festing does. That I think is perhaps the most cheerful thing that we electric light shareholders have seen for a long time. I myself know one or two private firms who are trying the electric light, and doing it at a less cost than if they were using gas. It is on these facts that we look to our future, not to the reports of gas companies and the statements of gas shareholders. It is where the light is put up by private persons who have no bias whatever, but who require a good light for the purposes of their business, and they get the light at a less cost than gas. I do not know that I can add anything to what I have now said. I have told you what we have done, what we are doing, and what I think our future may or should be. If any gentleman has any question to put, I shall be pleased to answer it

Dr. Mackenzie inquired where the Brush light could be seen in action in London.

The Chairman: You may see it any evening at the Promenade Concerts or at the Great Eastern and Great Western Railway Stations.

Mr. Havill asked the amount of shares subscribed for.

The Chairman: The number of shares subscribed and paid for by the public was 15,341, and altogether 75,682.

A Shareholder observed that the Company were acting under a concession from the Hammond Company, who, he believed, still held a very large interest.

The Chairman: Very large.

The Shareholder, continuing, said he had been very much struck by a paragraph in the City article of the *Standard* that morning. It was as follows:—" Mr. Hammond, the managing director of the Hammond Company, informs us that the new invention for which his Company are in treaty is 'not to work in connection with the Brush system, but in lieu thereof.' " Can the engineer give us any information of this invention which is to supersede the Brush system?

The Chairman: I will ask Mr. Hammond himself to give you the answer.

Mr. Hammond: Irrespective of the holding of the Hammond Company, I may say that I privately hold the largest number of shares in the Company. I applied for some 2,000 the first day the Company was advertised, and I got them all, so that to the extent of £4,000 of my private money I am vitally interested in the prospects of the Company. But, in such cases as these, I must divide my interests, and look at the matter purely from the point of view of the Hammond Company. It is quite true that the concessions held by this Company are held from the Hammond Company, and have reference particularly to the Brush machine and the Lane-Fox incandescent lamp. We, however, have always felt that, having started a sub-company in any particular district, we have got together a solid organisation for working our agency there, and that it would be to the interest of the Hammond Company to use that same company for anything that the Hammond Company might do in the future. Though not under covenants with this company to give them anything better that may come before us, we have decided that as long as the Birmingham and Warwickshire Company exists the fortunes of the Hammond Company shall be bound up with it. As to the new invention, it is one that will place the Birmingham and Warwickshire Company, in the particular districts over which it reigns supreme, in a position to do an amount of electric lighting that up till quite within the last few weeks was hardly dreamt of. I am scarcely at liberty at the present moment to give you the closest details with regard to the machine, but when I tell you that it is the joint production of Sir William Thomson and Mr. Ferranti you will understand how very important a stride is likely to have been made in that machine. When I tell you that the machine will, for incandescent lighting, give something like five times as much power as any machine in existence, you will see what an important step has been taken in making the house-to-house lighting possible, and at a very good profit. With regard to the Electric Light Act, the provisions of which we are taking the greatest care of, all through the whole of these districts consent has been asked of the authorities for lighting under the contracts. I felt that this work had better be done by the Hammond Company free of cost. We are actively engaged throughout the whole of the districts in making applications under the Act. Those licenses granted, we shall be in a position, if not with the machine held by the Company, with the machine which the Hammond Company will put in its way, to compete in the most satisfactory way possible with all competitors. I look on this Company becoming one of the soundest electric light companies in existence.

Mr. Soligue then moved a vote of thanks to the chairman, and in doing so said he thought the shareholders should place implicit confidence in the directors and those whom they had appointed as managers.

Mr. Poslethwaite seconded the motion, which was carried unanimously.

The Chairman, in returning thanks, said he should endeavour to do his utmost for the Company in the future. He had a large interest in it, and should try and push its fortunes to a successful issue.

An extraordinary general meeting was then held, and

The Chairman read the following resolution, to which it was proposed to ask the sanction of the meeting:—"That the Articles of Association of the Company be altered in manner following, viz.:—That Clause 40 thereof be cancelled. That from Clause 41 thereof the words following shall be omitted, viz.:—' Or the person entitled to the share by transmission as the case may be.' That from Clause 112 thereof the words following shall be omitted, viz.:—' Or otherwise interested.' " He stated that the alterations were required in connection with their application for a settlement and quotation on the Stock Exchange. They had consulted the solicitor, who had told them that the alterations were merely verbal, but to obtain a settlement and quotation on the Stock Exchange, which were so necessary to the existence of the Company, they were compelled by the Stock Exchange Committee to make them.

On the motion of Dr. Mackenzie, seconded by Mr. Thorpe, the resolution was unanimously passed, and the proceedings then terminated.

EDISON'S INDIAN AND COLONIAL ELECTRIC COMPANY (LIMITED).

A general meeting of the shareholders of this Company was held at the City Terminus Hotel, Cannon-street, on the 21st inst., at twelve, under the presidency of the Marquis of Tweeddale.

Mr. J. Forwood Tafe (the secretary) having read the notice convening the meeting,

The Chairman said: You are, no doubt, aware that this meeting has been convened under a section in the Companies' Act, which requires that a public meeting shall be held within four months of the formation of a company. There is no report, of course, so early in the life of the Company to submit to you, and, of course, no accounts, but I am here to give any information which may be desired with regard to the past and the future of the Company. The Company was brought out in June—on the 13th of June, I think.

The Solicitor (Mr. Birt): Incorporated on the 13th June.

The Chairman: Incorporated on the 13th of June, and on the Monday following the applications for shares amounted to 24,482, which were fully allotted. The number was not quite as large as we had anticipated, more especially having regard to the interest which the public had before that time taken in similar enterprises; but we ascribed that to the great attention which at that particular moment was being turned to affairs in the East, which very much disturbed the financial world, and occupied the attention of the public in general. The object of the Company was to acquire the patents and appliances which were the property of Mr. Edison, and which went to compose what is known as the Edison system of electric light. Mr. Edison, as probably every one here knows, is a gentleman of very high scientific attainments, who has devoted many years of his short but remarkable life in developing electricity in several forms. The one with which we are at present concerned is that which deals with lighting, both public and private, by electricity. No doubt there are many others in the same field who have made very important advances in this subject, but no one—I think this is admitted by every one—has done so much to render lighting by electricity practicable and possible as Mr. Edison. In fact, he has no competitor in this field as far as I am aware, and if there is any doubt on this subject in the minds of any present, they have only to look around them to see evidence of the fact. You have only to see what he has done—say, at the Holborn Viaduct, where a considerable district of this town is successfully

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lighted by electricity. You have only to go to the Post Office, where you see from the same centre a very important piece of successful lighting; and at this moment a very large portion of New York is being lighted by the Edison system. When you consider that the space in New York which is being lighted from a centre occupies a square mile, which is something like, if it were in London, from this to Charing Cross on one side, you may form some idea of the magnitude of this operation. But there is also some other remarkable evidence on this point—that he was the only one of all the exhibitors and competitors at the Crystal Palace able to obtain a very important medal, the gold medal for a general system of electric lighting. It is that system which we have obtained possession of through the medium of this Company, and the object of the Company is to give the benefit of it to our Colonies—India, Australia, Ceylon, and the Cape of Good Hope. With the view to prosecute our business we appointed a most able gentleman as general manager. Major Flood Page, whom we appointed general manager of the Company, was the gentleman who had occupied the position of general manager of the Crystal Palace for many years. He had occupied that position with great success. He is a gentleman of extraordinary energy, and I am sure will prove a most successful manager in the position in which he is now. No sooner was the Company formed than we naturally entered into negotiations with different substantial parties for the Colonies, and in intercourse with them we established the basis of agreements for companies in those parts. I may mention—it is not desirable to go into details to a great extent—that we have entered into negotiations for the formation of a company for the Cape of Good Hope and in two of the Australian Colonies. At the Cape of Good Hope there is every reason to believe that the Company will meet with success. One of the most important and successful of Mr. Edison's installations has been at the Cape, where the Parliament House was successfully lighted I think about a year ago. This light was carried out with complete success, and we have accounts from the Cape showing how gratified the public there are with this successful attempt to carry out electric lighting. The gentleman, Mr. Hortsek, who established the lighting there, is present at this moment, and is going out to Bombay very shortly with a similar installation there to give the people of that large and important town some idea of this system of successful lighting. I will not say anything more as to the negotiations with the Colonies and Australia further than this—that Major Flood Page left England at the beginning of this month, intending to land at the Cape, and then proceed to Australia, to carry out the objects of the Company; and the directors will be very much disappointed if, within a comparatively short time, some news of a favourable kind does not reach us from him. So far with regard to the business of the Company. With regard to electric lighting in general, I need hardly tell you that if I—and I believe I may speak for my colleagues—were not a believer in the electric light you would not see me here today. But the contrary is the case. I may say very emphatically that I am a firm believer in the electric light and lighting by electricity. I believe most firmly that it is the light of the future. I suppose every gentleman here has been able to form an opinion of lighting by electricity. I do not believe any one who has seen it can doubt that it is the most perfect light hitherto exhibited or attempted. As to the feasibility of it I think there can be no doubt, or as to its superiority over gas; but then comes the important question of cost. Now, that is at the very root of the whole matter, because, although the electric light may be very good for places where it can be afforded, it can only be general, and therefore only a commercial success, on the assumption that it will be generally employed, and it can only be generally employed if capable of being employed at a cost something similar to the cost of gas—perhaps even a little more, because its advantages are so great as to causing less heat and not injuring the atmosphere, &c., that I believe most people would be willing to pay a little more for the electric light than gas. Now, holding these opinions, I turned my attention, and my colleagues did also, to the question of cost, and without going into details I may give you the result of our inquiries. The result of those inquiries is this—that lighting by electricity can compete, and will be able to compete successfully when established on a suitable scale, with gas, even in England, and in countries where gas is as cheap as it is in England. That is the result of the inquiries which I have instituted for my own information; and you will bear this in mind—that gas at this moment is something over three shillings per thousand. If the electric light can compete with gas at a price of something like, or a little over, three shillings per thousand feet, it is quite clear that it will compete successfully with gas in other places where gas is much dearer. Take the case of the Cape. Gas at the Cape averages from twelve shillings and sixpence to fifteen shillings per thousand, and although I have not the details of the price of gas at Bombay, India, and the Colonies in general, I think I am right in saying that it is very considerably in excess of the cost of gas in this country. Consequently, if lighting by electricity is likely to pay in this country, it is all the more likely to pay in the Colonies and the East, where, as I say, gas is so very much dearer. It has one other immense advantage in the East as well as in the Colonies—that the use of it causes a far less raising of the temperature than the use of gas. This is not so important an item in cold countries. Indeed, one of the difficulties which electricity on a large scale will have to contend with in England is the very fact that it does lower the temperature to a very considerable extent in houses. This, of course, will not apply to public buildings, where it is the object to have a pure and cool atmosphere; but it is very important in small houses, especially the houses of the poor, who look to gaslight as a means not only of lighting their houses, but also of warming them. The very opposite is the case with the Colonies and India generally. The one great point in the light will be the low temperature prevailing where it is used. It will not only give a good light, but a light free from heat, and free from noxious vapours, which are very mischievous and injurious in hot countries such as India and Australia. Holding these opinions, that it is not only a good light, but also an economical light, you will understand that we have entered into this Company with the full belief that its operations will be attended with success; and I myself look forward with the perfect confidence of meeting you a year hence with a very good and successful report of our proceedings during the year. There is no resolution to offer, but I shall be very happy to answer any question asked by any gentleman present.

Mr. Campbell, with respect to the chairman's estimate of the cost of gas in the colonies, it being much dearer there than here, thought that in order to make comparison complete the shareholders should know the price of fuel there, and what difference that would make to this Company in working the dynamo machines.

A Shareholder stated that coal had been discovered in the colonies referred to, and observed that that fact would very shortly reduce the cost of fuel.

Mr. Campbell: Will not that reduce the cost of the gas?

The Chairman: The answer I should make to your question is that coal is by far the largest item in the manufacture of gas, whereas it is comparatively a small matter in the manufacture of electricity, especially in cases where water power is applicable.

Mr. Campbell: That hardly applies to Australia.

The Chairman: I hardly know that it does, but it does to many places.

A vote of thanks to the chairman and directors was then passed unanimously.

The Chairman, in reply, assured the shareholders that the directors would devote all their energies to the Company.

The proceedings then terminated.

DUPLEX ELECTRIC LIGHT, POWER, AND STORAGE COMPANY (LIMITED).

The first ordinary general meeting of this Company was held on the 18th inst. at the offices, Soho-square.

Dr. Lilley presided, and read a report to the shareholders on the working of the Company for the first four months of its existence. The allotment of the shares took place in May, £30,000 being issued at par, but since then 387 shares had been issued at 10s. premium. After expressing satisfaction with the premises secured at Soho-square, he alluded to the results of the working in the period referred to. Their profits, he said, had been the premium on shares £193, sale of a contract £500, and miscellaneous £123; and from a concession they had received £1,000 in cash and £3,875 in shares. They recommended out of these sums a dividend at the rate of 10 per cent. per annum, and a bonus at the rate of 2½ per cent. per annum.

Mr. Holliday seconded the motion, and it was carried.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Sept. 20.		Business Done Week Ending Sept. 20. Highest.	Lowest.
Anglo-American	51,	52	51⅜	51¼
Do. Preferred	82½,	83½	83¾	82½
Do. Deferred	20½,	21	21	20¾
Brazil Submarine	11⅞,	12⅜	12⅜	11⅞
Cuba	9¾,	10¼	—	—
Do. Preference	16,	17	—	—
Direct Spanish	6½,	7	6⅝	6⅝
Do. Preference	15½,	16½	—	—
Direct United States Cable	11½,	12	12	11⅞
Eastern Telegraph	10⅞,	11⅛	11⅛	10 15-16
Do. 6 per Cent. Preference	13,	13½	13 3-16	13
Do. 5 per Cent. Debentures, 1899	100,	105	—	—
Eastern Extension	11⅜,	11⅝	11⅜	11 5-16
German Union	9¾,	10¼	10⅛	10⅛
Globe Telegraph and Trust Company.	6⅛,	6⅜	6⅜	6⅜
Do. Preference	12⅝,	12⅞	12⅞	12⅞
Great Northern	12½,	12¾	12 9-16	12⅝
Indo-European	29½,	30½	—	—
Mediterranean Extension	1¾,	2¼	2⅜	2⅜
Do. Preference	8,	9	—	—
Reuter's	12¾,	13¼	—	—
Submarine	255,	265	—	—
West India and Panama	1⅞,	2	1⅞	1 13-16
Do. 1st Preference	8½,	9	8 13-16	8 13-16
Western Brazilian	6¾,	7¼	6⅞	6⅞
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Companies.	Closing Prices Sept. 20.		Highest.	Lowest.
Consol. Telephone and Maintenance	1⅜,	1⅝	1⅝	1½
Oriental	¾,	1	1	15-16
United Telephone	10½,	10⅞	10⅝	10⅝

ELECTRIC LIGHT.

Companies.	Closing Prices Sept. 20.		Highest.	Lowest.
Maxim-Weston	⅜,	⅝	½	⅝
Anglo-American Brush	11½,	11¾	13⅛	10⅞
Eastern Electric	2¼,	2½	2⅝	2½

TRAFFIC RECEIPTS FOR AUGUST, 1882.

Companies.	Aug., 1882.	Aug., 1881.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,550	2,401	49	—
Direct Spanish Telegraph Company	1,790	1,507	283	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	32,025	30,349	1,676	—
Eastern Telegraph Company	50,868	42,797	8	—
Great Northern Telegraph Company	23,360	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	3,400	3,185		—
Western and Brazilian Telegraph Company	—	—	—	—

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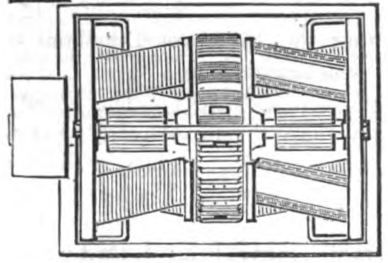
RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

931. IMPROVEMENTS IN DYNAMO-ELECTRIC MACHINES, *A. M. Clark, London.—25th February*, 1882.—(*A communication from H. B. Sheridan, Cleveland, U.S.*) 6d.

The object of this invention is to produce a machine in which the current induced in the armature will be without wide breaks and nearly continuous. The field magnets are made oblong in cross section, and arranged in two series in a circle around the armature shaft, with the poles of the opposing series facing each other, and arranged at a sufficient distance apart to receive the armature between them, the holes of each series nearly overlapping each other laterally, and forming a nearly continuous magnetic field. The armature core is a hollow iron ring, and is nearly rectangular in cross section. Its sides converge

931



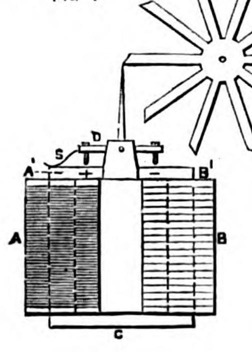
slightly from the periphery of the ring to its inner side. In the periphery of the armature core are formed a number of openings, and in the inner side a corresponding number. Upon the sides projections are formed, the outer surfaces of which converge, so as to be parallel with the sides of the body of the said armature. These projections form pairs of grooves, in each of which is wound a single helix of insulated wire. The outer end of one helix and the inner end of the other are joined, and both are connected with one section of the commutator. Our illustration shows a plan of the machine partly in section.

5295. IMPROVED MECHANISM FOR REGULATING THE FEED OF ELECTRODES IN ELECTRIC LAMPS, *H. E. Newton, London.—3rd December*, 1881.—(*A communication from A. I. Gravier, Paris.*) 6d.

The object of this invention is to ensure the release of the clockwork of a photo-electric regutator by means of a very small and constant differential action. To accomplish this, the inventor mounts two bobbins, A B, on base C, having cores, A^1 B^1, and an armature, D, of very light construction, and provided on either side of its axis of oscillation with limiting screws, as shown in Fig. 1.

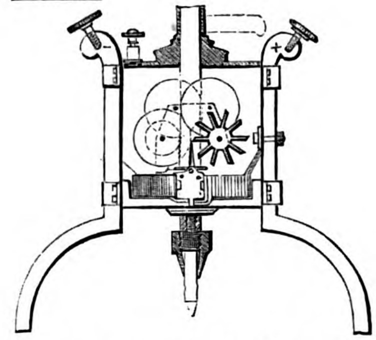
5295

FIG I



Spring S acts as a counterweight. Bobbin A, of fine wire, has a large resistance; bobbin B, of thick wire, a small resistance. B is placed in main circuit of lamp, A in a shunt from the main circuit. When the main current varies, the spring S will lift the armature and lock the clockwork, unlocking it again when the balance of re-

5295

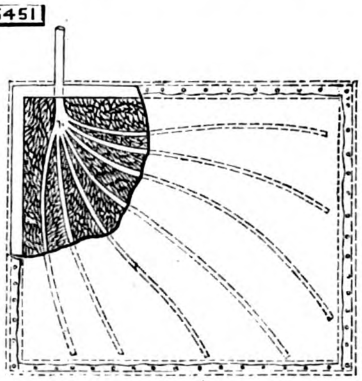


sistance has been restored. Fig. 2 shows the invention applied to a Serrin lamp.

5451. IMPROVEMENTS IN SECONDARY BATTERIES, *J. Pitkin, Clerkenwell, Middlesex.* 13*th December*, 1881. 6d.

The improvement consists in forming each electrode of a mass of very thin turnings or shavings of lead in a crumpled condition, packed in an open frame of wood, and enclosed in a covering of felt stretched over it on each side, to retain the lead in place, and allow it to be acted on by the

5451



liquid. The electrode thus constituted is connected with the terminals by means of a rod of lead flattened and cut or divided into a number of narrow strips or branches, which are distributed uniformly through the mass of the electrode, as shown in the figure.

5490. IMPROVEMENTS IN ELECTRIC LAMPS, *W. R. Lake, London.*—15*th December*, 1881.—(*A communication from J. A. Mondos, Neuilly, France.*) 6*d*.

This invention consists of an arc lamp, in which the arc is struck and the carbons regulated by the current itself, without any clockwork. The illustration explains how this is done. When

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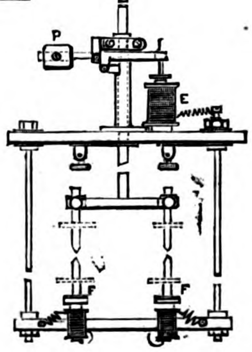
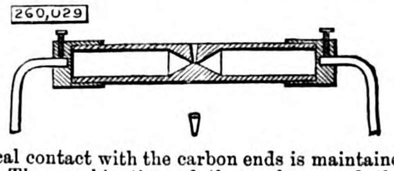


the current passes armature F is attracted, and the lower carbons separated from the upper ones. P is a counterweight, connected with which is a stop mechanism for holding the upper carbon, which is governed by the armature of the electro-magnet E.

260,029. ELECTRIC LIGHT, *Philip O. Jenkins, Washington, D.C.—Filed September* 28, 1881.

Claim.—(1) The combination of the enclosed carbon or other electrodes of like refractory and conducting capacity, their surrounding body of refractory non-conducting substance, the intermediate connecting-piece, which connects the two carbon points or electrodes, and the closely fitting caps of conducting material placed in close contact with the carbons and carbon-investing body, whereby the ingress of air is prevented and elec-

260,029

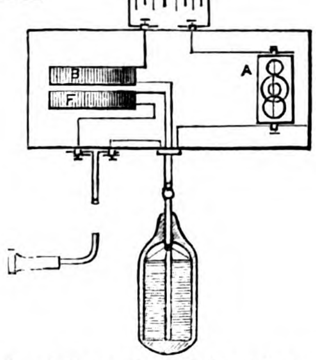


trical contact with the carbon ends is maintained. (2) The combination of the carbons and their enclosing body, the former fitted air-tight within the latter and the latter provided with a small conical orifice, and the conical or wedge-shaped plug adapted to fit said orifice so as to exclude the air from contact with the carbons, substantially as and for the purpose set forth.

5518. IMPROVEMENTS IN APPARATUS TO BE USED IN TORPEDO OPERATIONS AND IN SEARCHING FOR SUBMERGED BODIES, &c., *C. A. M'Evoy, Adelphi, Middlesex.—16th December*, 1881. 6*d*.

The apparatus consists of a box to be sunk in the water containing two bobbins of wire, supported by a cable containing insulated wires connected as shown to the coils on the bobbins. The

5518

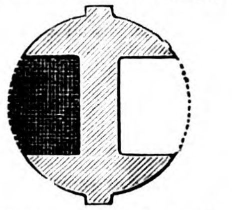


apparatus at the surface of the water consists of a battery, and two bobbins similar to those in the other box. The wire on one of the bobbins of each pair constitutes a primary coil, and that on the other a secondary coil, in which currents are produced by induction. In the secondary circuit is placed a telephone. Combined with the battery is an interrupter, A. For operation, the smaller box is lowered into the sea until it lies at the bottom. A current is then sent through the primary circuit, and the distance between the bobbins B and F is adjusted until no sound is heard in the telephone. The small box is then drawn slowly along the bottom. When any metallic body is approached by it, the balance between the two circuits is disturbed and loud sounds are heard in the telephone.

5551. IMPROVEMENTS IN ARMATURES FOR MAGNETO-ELECTRIC AND DYNAMO-ELECTRIC MACHINES, &c., *J. H. Johnson, Lincoln's Inn-fields, Middlesex.—19th December*, 1881. —(*A communication from W. W. Griscom, Philadelphia, U.S.*). 6d.

The improvements refer more particularly to armatures of the Siemens type, but are applicable to the poles of all other armatures. The invention consists in dividing extremities of the armature into two or more sections concentric with each other, one or more of such sections being at such a distance as to utilise the magnetic lines of

5551



force which fill the space between the two poles of the field magnets, whilst the other section or sections are arranged so as to pass in close proximity to the poles of the field magnets. The illustration explains how this is done; it represents a transverse section of an armature constructed according to this invention.

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SLIP

Scarborough.—The corporation have resolved to supply their own electricity, for lighting or other purposes.

Aden.—The prohibition with regard to telegrams in code or cypher addressed to this place has now been removed.

Electric Lights for Steamers.—It is stated that sixty steamers on the Mississippi are now using electric lights.

Electric Lights in San Francisco.—We learn that between 200 and 300 electric lights are in use in San Francisco.

Electric Light in Canada.—It is stated that the large stores in the main thoroughfares of Toronto are widely adopting the electric light.

Brazilian Submarine Telegraph Company.—The traffic receipts of this company for the week ended 22nd September, amounted to £3,503.

Personal.—We are informed that Mr. Frank Howard Landon, A.M.Inst.C.E., has resigned the position of secretary to the Maxim-Weston Electric Company (Limited).

The Varley Arc Lamp.—This lamp, which has but recently been patented, has been lately utilised to illuminate the space in front of the Ship Hotel, at Southend. The light given is said to have been good.

Electric Lighting for Manchester.—The City Council have been recommended to apply for a provisional order to supply electricity for public and private purposes within an area co-extensive with the City of Manchester.

A New Incandescent Lamp.—Rumours are afloat that M. Werdermann has patented a new form of incandescent lamp, in which silicium takes the place of the carbon heretofore made use of, and the vacuum is dispensed with.

The Electric Light at Alexandria.—The *Egyptian Gazette* states that Messrs. Allen, Alderson, and Co., who worked the electric light at Ramleh with so much success, have received an order to erect other lights at the Mex forts.

Electric Lighting for Leeds.—The special committee appointed by the Leeds Town Council to consider the Electric Lighting Act have recommended that a provisional order for the supply of electricity be applied for in December next.

Electric Railway at Moscow.—From the daily papers we learn that the Emperor and Empress of Russia paid a visit to the exhibition at Moscow on Friday week (22nd September) to inspect the exhibits, and rode on the electric railway.

Suez.—The Eastern Telegraph Company notifies the restoration of telegraph communication with Suez, Aden, South Africa, and India, by means of a new land line which has been constructed between Port Said and Suez, and is now open for traffic.

Western and Brazilian Telegraph Company.—The traffic receipts of this company for the week ended 22nd September 1882, were £2,309, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

West Indies.—The cable between St. Vincent (West Indies) and Grenada is interrupted. There is consequently now no telegraphic communication with the islands of St. Kitts, Antigua, Guadaloupe, Dominica, Martinique, St. Lucia, St. Vincent, and Barbadoes.

West India and Panama Telegraph Company.—The estimated traffic receipts of this company for the half month ended the 15th inst. were £1,647, as compared with £1,692 in the corresponding period of 1881. The June receipts, estimated at £5,089, realised £5,131.

The Edison System at Munich.—Four of Edison's K dynamos and about 800 lamps form the Edison exhibit at the Munich Electrical Exhibition. In order to test the economy and efficiency of the Edison machine, the current from a Z dynamo is to be sent through two miles of conductors.

Post Office Telegraphs.—The competition of young girls to obtain appointments in the Post Office Telegraphs is rather increasing than abating. An examination was held during this week at which there were no less than 800 candidates for thirty appointments. The salary commences at 10s. per week.

Liverpool Docks.—A correspondent laments the absence of telephonic communication with the Alexandra Docks at Liverpool, and remarks how useful such a means of conveying intelligence between the docks and merchants' offices would be. He suggests that the Liverpool Telephone Exchange Company should take the matter up.

Anglo-American Telegraph Company.—The board of directors of this company have resolved, after placing £37,500 to the renewal fund, to declare an interim dividend for the quarter ending 30th September of 15s. per cent. on the ordinary stock, and 30s. per cent. on the preferred stock, both free of income-tax, payable on the 1st November.

Electric Light Companies.—It is stated that there are thirty electric light companies in England, with a capital of over £6,000,000. The number in France is less, but the capital represented is nearly as great. There are over fifty companies in America, and the capital is considerably over £10,000,000. The average dividend is not known.

Electric Light on Shipboard.—The steamer, "Caroline," belonging to the Bay line, and plying between Baltimore and Norfolk, U.S.A., is to be lighted by the Edison system. There will be 100 10-candle lamps, the current being derived from one Z dynamo. The lights will be distributed through the saloons, state rooms, engine and boiler rooms.

Electrical Teaching in Germany.—*The Times* Berlin correspondent says, that in view of the great and growing importance of the subject, lectureships on electrical science and its applications have been established at Stuttgart, Aix-la-Chapelle, Karlsruhe, and Hanover, and this winter students will be specially instructed in the same subject in the University of Berlin.

A New System.—The Levett-Müller Electric Light Company of New York have been exhibiting a new system of electric lighting, the invention of Mr. Hans J. Müller, at Philadelphia. The Müller arc light employs an air check to regulate the movement of the upper carbon. An incandescent lamp has also been devised by Mr. Müller, but is not yet ready for use. The dynamo is also of Mr. Müller's invention.

English Postal Officials in Germany.—Messrs. Baines, Jeffery, and Forman, of the English Post Office, who are visiting Berlin on business connected with their department, were on Tuesday last received by Dr. Stephan, the German Postmaster-General. They were subsequently accompanied by a high official of the Postal Department over several post-offices and the central telegraph and telephone offices, and also inspected the arrangements for the parcel service.

Electric Lighting in the Provinces.—The electric light is getting into increased favour in the Midlands for the lighting of works and factories, says the *Engineer*. Several

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extensive and important factories in Birmingham are in communication with the Birmingham and Warwickshire Brush Electric Light Company, whilst manufacturers in Coventry, Burton-on-Trent, Rugby, Kidderminster, and other towns, are understood to have similar arrangements pending.

THE VOLATILISATION OF METALS IN VACUO.—It is well known that metals may be volatilised at elevated temperatures, the heat of the electric arc being sometimes used to effect it. M. Demarcay has recently made a series of experiments in which he observed the temperature of volatilisation of various metals in a vacuum. These he finds to be comparatively very low, cadmium volatilising at 160deg. Fahr., zinc at 184deg., antimony and bismuth at 292deg., and tin and lead at 360deg.

ELECTRIC LIGHTING IN BERLIN.—In a recent note we alluded to the successful lighting of the Leipziger Platz and the Leipziger Strasse by electric lamps. It should have been stated that the system employed is that of Messrs. Siemens and Halske, of Berlin, and that their differential arc lamps are used. At a recent convivial meeting to celebrate the first starting of the lights the Burgomaster congratulated Berlin on being the first city on the Continent which had adopted this mode of street lighting.

NEW HYDROPATHIC ESTABLISHMENT AT SEAFORTH.—A new hydropathic establishment has recently been opened at Seaforth, near Liverpool. It has been built on a very grand scale, and is splendidly fitted up. It is intended to employ the the surplus power of the engines used for pumping and other work to drive dynamo machines for supplying current to electric lamps. At present, we believe, no system has been definitely fixed upon, but it is under consideration to light the whole of the conservatories by this means.

ELECTRIC LIGHT FOR THE METROPOLITAN RAILWAY.—The extension of the Metropolitan Railway from Aldgate to the Tower was opened for traffic on Monday last. One of the longest portions of the tunnel is lighted by means of 200 Swan incandescent lamps, which are being tried as an experiment, it being intended, we believe, to extend their use to other portions of the line should they prove successful. The work of constructing the railway, which has been very difficult, has been carried out by Mr. T. A. Walker, well known as a large contractor.

THE LIGHTING OF LONDON BRIDGE.—A correspondent in *The Times* has called attention to the inadequate lighting of London Bridge. Since the removal of the Siemens electric light the darkness in that locality has become more "visible," and the danger is naturally increased. We understand that the subject will be fully considered by the Commissioners of Sewers, with a view to the improvement of the lighting either by electricity or a better method of gas illumination. We hope that the electric light may resume its place on the bridge before long.

CENTRAL AND SOUTH AMERICAN CABLE.—A part of the staff engaged in laying the Central and South American cable arrived at Plymouth on Wednesday on board the Royal Mail steamer "Nile." They numbered forty-two altogether, including electricians, engineers, and others. They have been occupied in the work about twelve months, and it has been accomplished without a single serious hitch. The remainder of the staff, numbering 120, are at Panama, under the direction of the chief electrician, Mr. Thomas Gray. The steamers engaged were the "Dacca," the "Silvertown," and the "Retriever," belonging to the Silvertown Company. Mr. Matthew Gray, the second electrician, has also returned home.

ELECTRIC LIGHT IN HULL.—At a special meeting of the Lighting Committee of the Hull Corporation, held on Tuesday last, a letter was received from Messrs. Siemens Brothers, stating that they were ready to commence their contract for lighting a portion of the town at any time that the Committee might think fit. After some discussion it was resolved that the lighting should be inaugurated on Thursday, and we expect, therefore, that before these lines are in our readers' hands, Messrs. Siemens' contract for lighting a portion of Hull for the next twelve months will have been entered upon.

UNIVERSITY COLLEGE, DUNDEE.—The Council of the College are inviting applications for the following chairs:—Mathematics and Natural Philosophy, Chemistry, and Engineering and Drawing. The salary to be attached to each of these chairs is £400, with two-thirds of the fees, which will be guaranteed for the first five years up to £100—making the total guaranteed income of each professor at least £500. Further information may be obtained from the secretaries, Messrs. Shiell and Small, solicitors, 5, Bank-street, Dundee, with whom applications, accompanied by 20 printed copies of testimonials, should be lodged before the 17th October.

ELECTRICAL ENGINEERING.—Professor W. Grylls Adams, F.R.S., is announced to deliver a course of lectures on electricity at King's College, Strand, during the ensuing session. A course of practical work in electrical testing and measurement with especial reference to electrical engineering will also be carried on under his direction in the Wheatstone Laboratory. The lectures will be given once a week, on Thursday, at 2 p.m., and the laboratory will be open daily (Saturday excepted) from 1 to 4. The work will begin on Monday, October 8. For further particulars apply to Professor Adams, King's College, London.

THE ANGLO-AMERICAN ELECTRIC LIGHT COMPANY.—The following appeared in a recent issue of the *Gazette*:—"At a general meeting of the Anglo-American Electric Light Company (Limited), held at 112, Belvedere-road, Lambeth, on the 23rd August, the subjoined special resolution was passed, and, at a subsequent extraordinary general meeting of the company, held at the same place, on the 13th inst., the resolution was duly confirmed: 'That the company be wound up voluntarily under the provisions of the Companies' Acts, 1862 and 1867, and that Alfred E. Jarvis be and he is hereby appointed liquidator for the purposes of such winding up.'"

THE VELOCITY OF LIGHT.—Preparations are nearly completed at the Case School of Applied Sciences, Cleveland, Ohio, for a re-investigation of the velocity of light, by Professor A. A. Michelson, late of the Naval Academy at Annapolis. According to measurements made by Professor Michelson in 1879, the velocity was found to be 186,380 miles a second, a result which differed slightly from that obtained by M. Cornu at the observatory at Paris in 1874, and also, it is said, from that obtained more recently by Professor Newcomb at Washington. The results of the last-named observations have not been published. Mr. Michelson has accordingly been requested to repeat his experiments, money for the purpose, about 1,200dols., having been promised from the Bach Scientific Fund.

THE TELEPHONE IN ST. PETERSBURG.—*L'Electricien* learns that the Société Technique Russe has, at the wish of the management of the Electric Exhibition at St. Petersburg, established telephonic communication between the exhibition and the opera house. Eight Blake telephones have been placed in the opera house, and are worked with one Leclanché cell each, another being ready for switching on, however,

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when the first is exhausted. The secondary wires of the transmitters are grouped four in a series, so that there are two circuits leading to the exhibition, each composed of an insulated wire with earth as the return. The two wires have been erected one at each side of the canal to avoid induction effects, an advantage, certainly, but which is paid for by a double expenditure on posts. Each of these lines, including the apparatus, has a resistance of 1,171 ohms. The receivers are twenty in number for each circuit, or forty in all, allowing twenty persons at the same time to hear the performances at the opera.

Death of Mr. A. J. Hare.—The *Madras Times* records with regret the death of Mr. A. J. Hare, superintendent of the Eastern Extension Cable Telegraph, at his residence in Rundall's-road, Vepery, on the afternoon of August 26. He had been ailing from a stubborn attack of fever for the last month, brought on from exposure at Bombay, whither he was sent by Mr. Leggatt, of the Telephone Company, to rectify the bad working there. Inflammation of the heart set in, and he succumbed to the disease. Mr. Hare's successful official career has thus been cut short at the early age of thirty. He came out in 1870 with the laying ships, and was appointed a clerk in Madras when Mr. Lundy was superintendent, from which post he was promoted to the office of clerk in charge. He was then transferred to Rangoon as superintendent, and when a vacancy occurred in the Madras office by the resignation of Mr. McLaren, Mr. Hare was appointed to the responsible post of superintendent in Madras at the age of twenty-five.

Electric Search Lights.—From the military and naval news of a daily contemporary we take the following item:—The "Hotspur" raised steam alongside Devonport Dockyard yesterday (Thursday, September 21) for trial of the electric lights which have been placed on board, for the production of which she is provided with two Gramme machines, driven by an engine of 17 horse-power. These lights are exhibited from two projectors on the superstructure, and have a complete sweep of the horizon. With both machines concentrated on one lamp a light equal to 2,200 candles was produced. These lights, when the powerful reflectors, which cost £200 a piece, are employed with them, are enormously increased in power, being said to be equal to nine million candle-power in a clear atmosphere at a distance of from half a mile to two miles. The trials took place under the direction of Mr. Lane, Admiralty electrician from Portsmouth yard, and were witnessed by several officers of Devonport dockyard, as well as those of the ship, who took advantage of the machines being at work to ascertain whether the spare compasses, which are stowed in a closet just below, would be affected. The test proved that they were not affected at all.

Telegraph Poles Wanted.—Tenders will be received by the Postmaster-General until noon on the 23rd of October for 4,832 red fir telegraph poles, to be delivered in London; 4,870 (minimum) or 12,741 (maximum), to be delivered either at Northumberland Dock (River Tyne) or at West Hartlepool; 2,680 to be delivered at Perth, and 5,191 to be delivered at Dublin. The poles to be felled between the 1st November, 1882, and the 28th February, 1883, and to be delivered during the following summer. Tenders are also invited for creosoting the above-mentioned poles with 8lb. or 10lb. of creosote to the cubic foot, as may be decided. Tenders may be submitted either for (A) supply of the poles only, (B) both supplying and creosoting, or (C) creosoting only; but, if B be tendered for, tenders for A and C are also requested. The poles to be delivered at the port at which the creosoting is to be performed. Any person who has not previously supplied the Postmaster-General with poles must submit their butt sections from not less than three different poles to show the quality of timber offered. Forms of tender, containing all particulars, may be obtained on application, either personally or by letter, to Mr. W. H. Winter, Controller of Stores, Telegraph-street, Moorgate-street, E.C.

The "Scotia."—After an absence of three weeks, the cable-laying steamer "Scotia," Captain Cato, has returned to Plymouth, having successfully completed the repair of the cable of the Anglo-American Company from Brest to New York. It will be recollected that this vessel entered upon her task in May last. The break in the cable having been discovered, the position being 1,000 miles from the Channel, the cable was taken up and joined, and the "Scotia" left mid-ocean to make good the cable 400 miles from Brest, a "fault" having been ascertained to exist. While engaged in the second operation it was found that communication could not be had with America. Tests proved that the cable had parted where it had been joined. The "Scotia" came into Plymouth, replenished her bunkers, and again left. Having repaired the cable off Brest, the vessel proceeded to the position of the breakage, which was but twenty miles eastward of the spot where the cable had first given way. Great difficulties were encountered in taking up the wire and buoying it. It lay on a deep and uneven bottom, and time after time, after it had been buoyed, the buoys were carried away. When, a little more than a month since, the "Scotia left the Atlantic for Plymouth, the eastern end was buoyed. On her return, however, the buoy had disappeared. No further mishaps were encountered. The cable was completed, messages were passed through, and the "Scotia" was ordered to Plymouth.

Thunderstorms.—Severe thunderstorms are reported as having occurred in Warwickshire and the Central Midlands on Wednesday. One of great severity occurred at Nuneaton. The lightning was incessant and very vivid, and the thunder deafening. Many accidents are reported, but happily no loss of life. At the residence of Miss Heath, Nuneaton, the lightning struck the gable end of the house, entirely stripping it of the tiles. A thunderbolt entered the window of the kitchen where three women were at work, and exploded with a tremendous noise, fortunately doing no harm. A house occupied by the Rev. J. Davenport, curate of St. Nicholas Church, was also damaged by the lightning. After striking the chimney of the building and stripping the tiles from the roof, it seems to have divided, part running down the exterior of the house, whilst the remainder passed through the chimney into the kitchen below, and made its exit by the partly opened window. The building was much shaken. A woman named Minard, living in Abbey-street, had a narrow escape from being burned to death. A ball of fire is described as having descended the chimney, after splitting the stack, and entered the kitchen where Minard and two children were seated. The woman's hair, and also her clothing, were set on fire instantly, and her face terribly blackened and scorched. The ball then made its way out of the open window of an adjoining room, and burst in a plot of ground in front of the building. The roof of Attleborough Hall was also struck. Hailstones of extraordinary size fell during the storm. A heavy thunderstorm passed over Sheffield the same day. At Lower Wincobank two houses were greatly damaged by lightning, which broke all the panes of glass, partially wrecked the chimneys, damaged the furniture, and on passing out underneath one of the doors smashed a stone slab. A thunderstorm also

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visited Clay Cross, in Derbyshire. The lightning struck the post office telegraphic instruments, suspending communication. The postmistress was hurled to the ground and rendered unconscious.

Cutting Telegraph Wires.—We extract the following from a Birmingham paper of recent date:—At the Police-court, Moor-street, before Mr. Kynnersley (stipendiary) and Dr. Russell, Henry Jones, 56, a foreman, and George Brown, 46, a labourer, employed by Mr. Fitzmaurice, contractor, Tindal-street, were charged with cutting and stealing twelve yards each of thirty-three wire telegraph cables. The men were at work, with a number of other labourers, in Corporation-street, on Tuesday last. They were excavating to lay sewage pipes, and near the corner of Newton-street came upon a number of postal telegraph cables. Although they had no right to touch these, and could have done their work just as well if they had left the cables as they found them, Jones, the foreman of the gang, ordered them to be got out, pretending that he thought they were dead or unused wires. Accordingly the wires that protruded from the earth were fastened to a chain, to which two horses were yoked. By this means about twelve yards of the cables were drawn out of the ground, cut off, and given to one of the men, who took them to an ironmonger's close at hand. They were fetched from thence by another man, who, acting under the instructions of the ganger, Jones, sold them for 4s. 6d. When the chain was being drawn out a policeman passed, and he saw Brown guiding the wires as they were drawn out of the earth. When Jones was taken into custody he said he saw he should have to say all he knew, or they would put the blame on him alone. The other men were as bad as he. When confronted with Brown he said the latter cut the wires off.—Mr. John Dawson, engineer and inspector, in the employ of the Postal Telegraph Department, said that as far as he could judge there was no necessity at all for the wires to be interfered with in the laying of the sewers. Serious inconvenience had been caused by the wires being cut, as direct communication with Dublin, Cork, Glasgow, Bristol, Paris, New York, and other places was for a time interrupted. The value of the wires when new was £3.—The prisoners were committed to the sessions, and the stipendiary magistrate told them they might anticipate a very severe sentence, which, we may add, they justly deserve.

The Edison System in Powder Mills.—A correspondent sends us the following description of the fitting up of twenty-four powder mills at the Poudrerie Nationale de St. Chamas (Bouches-du-Rhone), France, by the Edison system:—"Under the direction of Mr. J. Harris, electrical engineer to the Société Electrique Edison of Paris, assisted by Mr. Henry Warde (late of the Edison Electric Light Company of London), an installation of 64 A lamps has been successfully completed. The armature is driven at the rate of 1,200 revolutions, the power being derived from a system of power-transmission, which begins at an outward flow water-turbine, 30ft. in diameter, which revolves five times a minute, the source being the river Touloubre, fifteen miles distant. A canal leads from the river, and, as it nears St. Chamas, it passes under the roadways, and, by hydraulic pressure, enters the mountain, passing through to the opposite side, at the base of which is situated the Poudrerie Nationale, where three miles of branch canals supply power to sixteen turbines, which night and day operate the powder mills. The continual flow of water over arches, under which are electric lights, keeps everything in a constant state of humidity. To obviate any difficulty from this, and also any possible danger from fire, the 12,000ft. of double lead-covered wire employed is wholly laid under ground or in cement. Under each of the fourteen arches is placed one A lamp, twenty are employed as street lamps in various parts of the grounds, six are used in the offices, and twenty-four within the powder mills, where the electric light shows the details of machinery in pleasing contrast to the dull rays of the oil amps which formerly existed. Embedded within the wall of each mill is a safety plug with waterproof and fireproof cover, also a safety fusible wire is placed at the dynamo, thus avoiding excess of current passing through the mains. The dynamo runs without rest twelve hours every night. The director and chief engineer express 'great satisfaction with the Edison light as applied to powder mills,' and those of the 300 workmen who labour at night, realising the safety and cheerful brightness of the new light, are emphatic in their thanks for the practical application of such a system."

Telephonic Communication with Divers.—The *Sunderland Herald* of the 23rd September says:—"As stated in our issue of yesterday, with a view of testing the practicability of using the telephone for submarine purposes, Mr. Wake, engineer of the River Wear Commissioners, and Mr. Irish, manager of the Northern District Telephone Company, have been engaged in a series of experiments with a telephone arrangement specially devised by the latter for conversing with a diver in his dress when engaged in submarine work. On the 15th inst., by the kind permission of Mr. Wake, one of his divers, Mr. Stone, descended in his dress to the bottom of the dock, where he successfully carried on an animated conversation with persons on *terra firma*, and in order to test thoroughly the practicability of the apparatus he asked at various times for implements used in diving operations to be sent down to him, and put questions to the persons on land as to the time of the day, the health of various persons with whom he conversed, the distance he was from the dock side, and stated that he was about to ascend, &c. On the other hand the persons on land interrogated him as to the condition of the bottom of the dock, the depth of water, whether the supply of air through the pumps was satisfactory, as to his whereabouts in the dock and when he was coming to the surface. Although, under the circumstances, it would hardly be expected that the apparatus would work as successfully when submerged as when it is above ground, in consequence of the action of the air pumps, the result proved that it was as well adapted for submarine purposes as for others. These experiments having proved so successful, it was thought advisable to exemplify the same at the North-East Coast Exhibition at Tynemouth, and on Thursday the telephone in a diving dress was severely tested by Mr. Lambert, of the firm of Siebe and Gorman, submarine engineers, who descended on three occasions during the afternoon into the diving tank, and placed himself in all the positions that a diver has to assume in order to carry out his work. The length of cable used in these experiments, through which the conversations were carried on, was 600 yards. The want of a system of verbal communication with a diver in his dress, &c., had long been felt, and, as is above exemplified, it has now been met. We also noticed a few days ago in connection with the diving bell, that a telephonic arrangement had been fixed by the Post Office authorities for communicating between persons in the bell and on land; but we are informed that, although sounds in the bell could be heard on land, a conversation could not be successfully carried on by this arrangement. It appears to us that if conversation can be successfully carried on with a diver in his dress, there should be no difficulty whatever in doing the same with persons in the bell."

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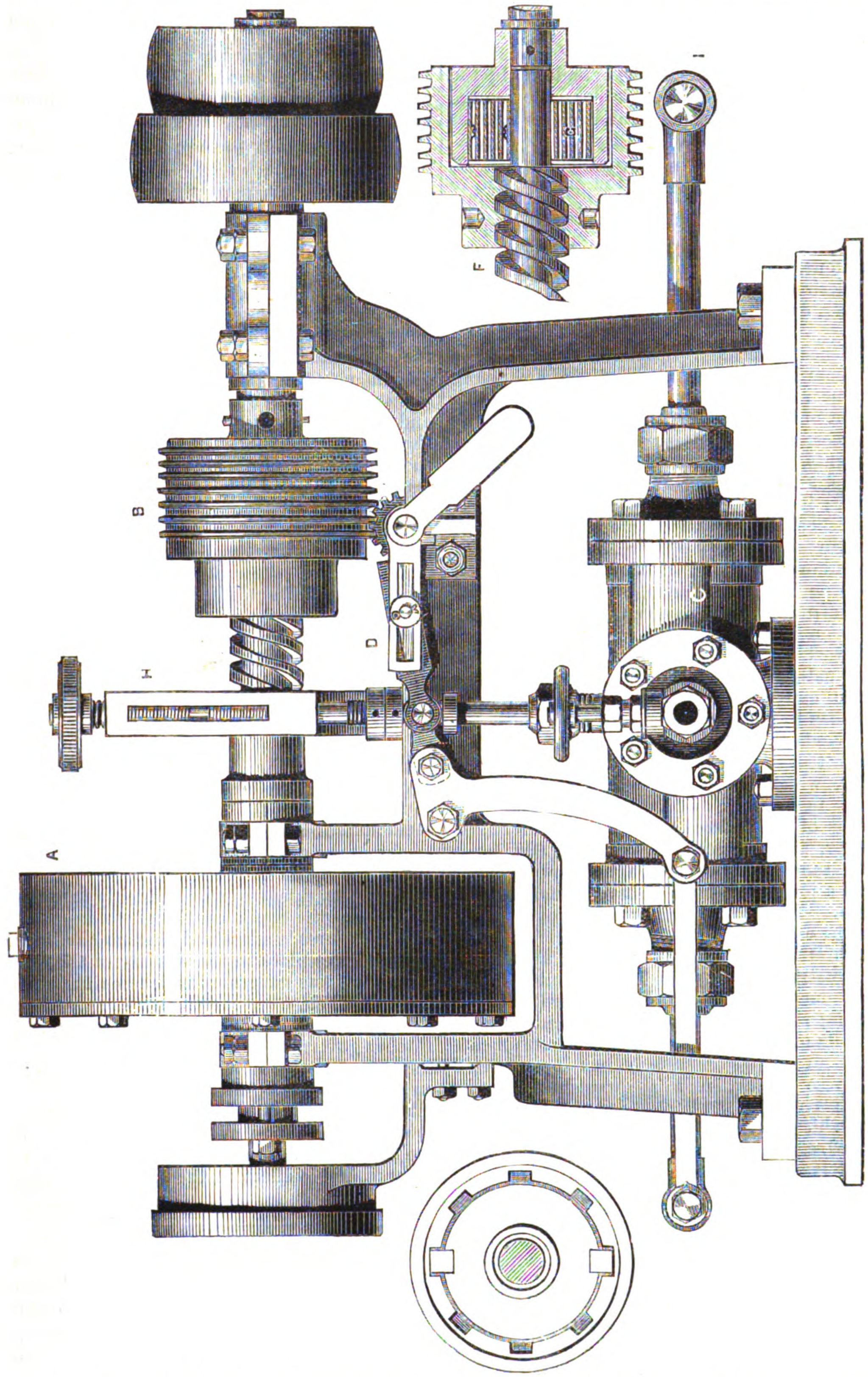
DURHAM'S GOVERNOR FOR ELECTRIC LIGHT ENGINES.*

CONSTRUCTED FOR MR. W. SPOTTISWOODE, F.R.S., COOMBE BANK, SEVENOAKS.

That a governor is needed for the control of a steam engine driving electric lighting machines there is no doubt, and that such a machine should be capable of the utmost delicacy and adjustment may be taken as a matter of course. Some experiments recently carried out at Coombe Bank, the residence of Mr. Spottiswoode, F.R.S., near Sevenoaks, serve to show to what perfection a governor can be brought. The machine alluded to, and which we illustrate this week, is one of Durham's patent velometers, and, as this machine is now so well known, it is not necessary to give any detailed description of its action, beyond reminding our readers that the general principle is the combination of a water cylinder with a steam one. The machine is driven from the engine shaft by means of a rope made of cow hide, which passes round a pulley on the main spindle; at a certain point this spindle is cut, and one end is attached to the inside of a coiled



Durham's Governor for Electric Light Engines.

* We reprint this article from our excellent contemporary, *The Engineer*, to whom we are also indebted for the illustration.

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spring C, while the other part of the spindle, which carries a fan revolving in a closed water cylinder A, is attached to the outside of the same spring. When the engine is running, the rotary action is communicated from the engine shaft to the pulley on the governor spindle and through the spring alluded to above, to the fan in the water cylinder. It will be at once seen that should the engine from any cause, such as the loss of resistance, tend to run at a speed higher than is desired, the pulley on the first governor spindle will run faster than the fan on the second, and the difference of speed so obtained sets up an action in the spring, which action is used for the moving of a slide valve on a steam cylinder C by the gear B D F, the piston rod of which is connected to the throttle valve of the engine by the rod I, and in this manner the working of the engine is controlled. By simple adjustments and a counteracting spring H, any desired number of revolutions may be allowed, but should the engine tend to run ever so slightly over such a speed, it is immediately checked and rigidly kept to the rate of running settled upon. The counteracting spring is capable of such nice adjustment that by its means alone, the stop valve being full open to the engine, any speed desired may be obtained within the limit of the engine's power, even to the bringing of the machinery to perfect rest.

Some little distance from Mr. Spottiswoode's house a handsome engine room has been built, and within it is placed all the machinery necessary for the purposes of supplying light, water, &c., not only to the dwelling house itself but to the stables, outhouses, and the pleasure grounds. All the machines, instruments, tools, &c., to be found within the engine room are kept scrupulously clean and in order by Mr. Volter, the engineer; indeed, his department looks more like a handsomely furnished mechanical museum than what is conventionally known as an engine room. At one side is the engine, which is horizontal, and of about 12 horse-power nominal, and has been built by Messrs. Middleton and Co., of Southwark; the cylinder, which is steam jacketed, is 11in. in diameter, and has a stroke of 2ft. It is fitted with two expansion valves working on the back of the slide valve, and capable of adjustment and alteration by means of a hand wheel at the end of the valve chest, which moves the right and left-handed screwed spindle upon which the valves work. A fly-wheel, 10ft. in diameter and weighing some four tons, is fitted to the crank shaft. Steam is supplied from a boiler, which is situated in a recess shut off from the engine room by means of a glass door and partition. The boiler is of the vertical type, stands 12ft. high, is 4ft. 6in. diameter, and is provided with four 9in. cross tubes. It is by the same maker as the engine, and steam is supplied from it at a pressure of 50lb., hard Welsh smokeless coal being used. Near to the boiler room door, beside the engine, where the easiest and most direct connection can be made with the throttle valve, and standing on a pedestal, the governor we illustrate is placed. In the centre of the room the dynamo, one of De Meritens', is fixed, a light polished rail running round it as a protection against accident, and by the walls many other machines and instruments are placed, while an alcove or recess has been fitted up with a vice, vice bench, and a quantity of tools for the use of both engineer and electrician. The whole system of lighting, which is under the superintendence of the electrician, Mr. Ward, consists of four circuits of incandescent lamps—Swan's—30 lamps making up a circuit; four large arc lamps, one at each corner of the outside of the dwelling house, and 10 large arc lamps, which are situated among the trees in the park, and which produce a beautiful effect on the foliage and terraces as seen from the drawing room windows. In the experiment to which we have referred, when the engine was first started it was run slowly for a little while, being occupied in pumping water to the top of the house; but when darkness set in it was called upon to run the dynamo, and the experiments were carried out. The engine being driven at an uniform speed of 58 revolutions, caused the dynamo to make 900 per minute, and in making this 900 it emitted a sharp, clear musical note. That the pitch of this note would form an absolute guide to the speed of this machine was accepted, for were the engine to run at ever so slightly an altered speed the difference would, of course, be communicated to the dynamo in the proportion of 58 to 900, or nearly 16 to 1. And if it be accepted that one revolution of the engine would very perceptibly alter the note, a gauge is established by which the regularity of the engine is tested to an increase of one revolution. At the beginning of the first experiment the four large arc lamps, before spoken of as having been placed at the corners of the house, and which Mr. Ward considers require some 5 horse-power to drive, as well as one circuit of incandescent lamps, requiring about 3½ horse-power, were lighted. By means of a telephone in Mr. Spottiswoode's laboratory, the note of the dynamo could be distinctly heard. At a signal arranged beforehand, Mr. Ward threw off the arc lamps, leaving the Swans on, but the note of the dynamo remained absolutely the same, proving that the governor had attended most promptly to its duties. Previous to the application of the governor in the engine room, it had been necessary for the electrician to telephone to the engineer of his intention of making any change; the engineer had then to look after his engine, and the constant result was that valuable lamps were destroyed. Now nothing of this kind is needed, and Mr. Volter in the engine room is quite ignorant of any change, however great, which may be made with the lighting, for the governor works so silently and so steadily as to attract no attention. In carrying out the second experiment the same lights were used, *i.e.*, 30 incandescent and 4 arc. The incandescent lamps were first put out, but the intensity of the light from the arcs remained the same; the operation was then reversed, the arc lamps being suddenly put out, and the light of the Swans was declared to be absolutely unaltered. The third experiment was the most crucial one, but from it also the governor came out satisfactorily. It was decided to light the entire system and then to throw them off simultaneously. The telephone having now been brought into use in order that the note might be closely listened to, the signal was given and the entire system of lighting was suddenly thrown out, but the note continued in the engine room unaltered. Mr. Durham was anxious that one more test should be made, and the experiment, which we may call No. 4, was carried out in the engine room. At the beginning of the experiment the machine was being driven at its usual speed (900), only a few lights, however, being left burning. The dampers were then put on to the boiler, and firing was stopped, the pressure gauge registering 50lb. The steam then fell pound by pound without producing the slightest variation in the note of the machine, the engine making still its normal 58 revolutions. When the steam had fallen to 30lb. by the gauge the driving belt of the dynamo was suddenly thrown on to the loose pulley, but the crank continued to keep at 58 revolutions. It is, of course, understood that no governor can act unless a change takes place in the velocity of the engine, but whereas there are some governors which maintain a constant relation between their own speed and the position of the throttle valve, there are others—as for example the well-known Pitcher governor—which, running faster for a moment, set the throttle valve in a new position, and then return to their own old position. This is also done by the velometer, the alteration in the speed of the engine and dynamo necessary to effect the change of position in the throttle valve being too brief in duration to be noticed by the ear, or to produce an appreciable effect on the lamps in circuit.

A Steamer Struck by Lightning.—During the last voyage of the steamship "Kirkheaton," Captain Cook, from Goole to Bruges, when she was but a few miles from the mouth of the Humber, bearing towards the Newark lightship, a violent thunderstorm broke over the ship. In the course of it a violent shock was experienced, as if she had been in collision with another vessel. The portion of the crew who were below ran on deck to see what had happened. It is believed that, though no damage was done, the vessel must have been struck in some way or other by a flash of lightning.

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NOEL'S PRINTING TELEGRAPH.

The printing telegraph apparatus of Dr. Noel, of Noyers St. Martin, Oise, France, was to have been exhibited at the International Electric Exhibition, at Paris, but owing to his being unable to find any one who would undertake its construction in the brief time which was allowed him before the final date for sending in applications for space, he was compelled to make public a description only. We give below a translation of this description from the original French, together with a diagram illustrating the principle of the apparatus.

My apparatus (says Dr. Noel) constitutes a multiple and duplex printing telegraph, of which the distributor is based upon a principle altogether different from that of Meyer and of Baudot. Its object is to obtain from a telegraph line the maximum duty it is physically capable of affording. It can be adapted to the systems actually in use, such as that of two messages of 10 words in the same space of time, or 120 per minute, or 7,200 per hour.

It would be impossible to utilise this considerable number of currents with a single electro-magnet at each station; but, by dividing them amongst the total number of magnets in all the series, in such manner as to transmit only one at a time through each magnet, I am able to utilise each and all successively.

Since at least five currents are requisite for printing a letter, and the apparatus is arranged for duplex transmission, it follows that each operator must have at his disposal five electro-magnets—five for transmission and the same number for reception. These magnets are alternately arranged, from the first to the last series, so that a transmission current succeeds a reception current, and so that all the particular series constitute one general series.

The currents can pass to the magnet coil only through the armatures themselves, A B Fig. 1. The armatures A com-

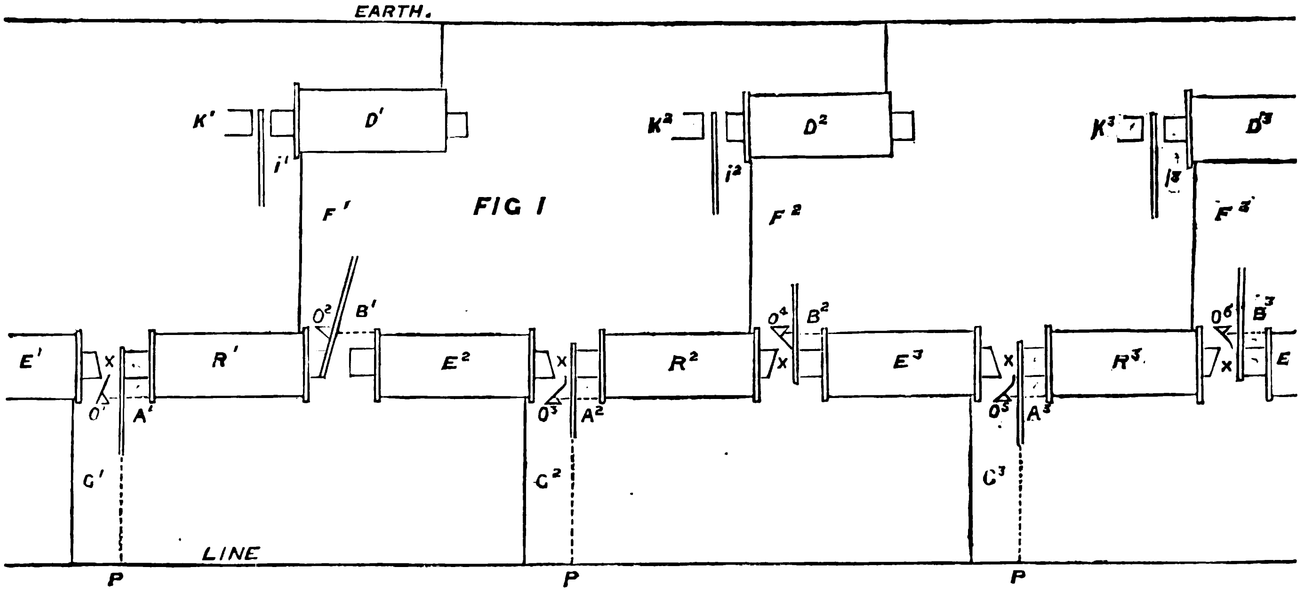


FIG 2

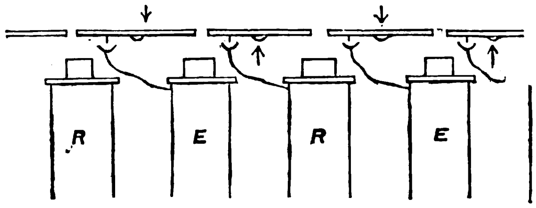
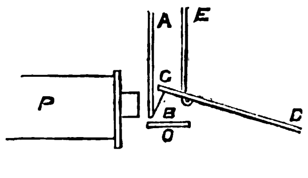


FIG 3



Noel's Printing Telegraph

Morse, of Wheatstone (rapid transmission), of Meyer, of Baudot, &c. In this case it would augment the duty more than ten times.

It is composed of as many sets of ten electro-magnets as there are operators, and the possible number of these is, I venture to say, almost unlimited. These electro-magnets are of very small dimensions, with comparatively large wire, so as to allow of those rapid magnetisations which, as M. Marcel Deprez has shown, may readily amount to from five to six hundred per *minute*,* and may even reach a much higher figure, since this skilful electrician obtained the prodigious number of 3,200 signals in the same space of time, by reducing to half a thousandth of a second the period of magnetisation of his electro-magnets. I have no need to reach this extreme limit, but can stop at 500 magnetisations per second, giving, if I can utilise them properly, a duty of from 100 to 120 letters per second—say, municate directly with the line at P. The armatures B each communicate with a key of a key-board which is under the hand of the operator. The depression of this key places the armature in connection with the positive and its return with the negative poles of the battery. To the left of each armature is a metallic contact-piece, O, which, however, is not of iron. To each of these contact pieces is soldered the wire from the right-hand coil of the magnet.

Each armature successively performs two movements, the first to the left, the second to the right, and the movement to the left is simultaneous with the movement to the right of the neighbouring armature to the left, whilst the movement to the right is simultaneous with the movement to the left of the neighbouring armature to the right. These simultaneous movements break the circuit when the movement to the left occurs, and close it when contact is made to the right—that is, break the current on one side and at the same time establish it on the other side.

The arrangement of the armatures in Fig. 1 indicates that

* Evidently this should be "second."—*Translator.*

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a current has just been sent to line from the transmission station through the coil E_1 and the wire G_1. Its passage through the coil had attracted the armature A_1 to its contact-piece, O; but immediately this allowed the current of the receiving station, by means of this contact, to pass also through the armature A_1 and its contact-piece to the coil R_1, and thence to pass to earth by the wire F_1, the relay D_1, and the earth-wire. The moment its effect—that is, the magnetisation of the coil R_1—has been produced, the current cuts its own passage through O by the attraction of the armature, which has now left O to come into contact with the soft iron core of R_1; and by the same action it opens a path for a transmission current, through B_1, O^2, the coil E^2, the wire G^2, and the line-wire. The current which is about to pass through E^2, whilst it will cut its own path at O^2, will open a path at O^3, by the attraction of A^2, for a fresh reception current, which, passing through R^2, renews the action of the armatures and the production of the same effects.

The duration of each current comprises the period of magnetisation necessary to produce the attraction of the armature, and the period occupied by the latter in moving into contact. Between each current there is a period of rest, during which no current passes; this is the time occupied by the two armatures in passing from one to the other contact.

If the movements of these two armatures were not simultaneous—if A_1, for instance, had not broken contact when B_1 makes contact, the working of the apparatus might be faulty, for then the current which passes by B_1, the coil E^2 and the wire G^2 might, instead of passing through the line-wire to the other station, again pass by the armature A_1, its contact piece O_1, the coil R_1, the wire F_1, and the relay D_1, and thence to the battery through earth.

It is in order to obviate this danger—which is more imaginary than real—that the contacts O are not made of iron, so that the armatures may not be retained by the effect of residual magnetism. For the same reason the armatures make contact on the right hand with the soft iron of the electro-magnets, since on this side I have no fear of the effect of residual magnetism, but, on the contrary, endeavour to obtain it, in order that, if the movement of the armature should not be simultaneous, the armature on the left hand may become detached from its contact a thousandth of a second sooner than the armature on the right. By this plan the currents connot in any case work back and take the wrong path.

Another defect in the apparatus might arise from the failure of a contact, leading to a break-down of all the transmissions, since the magnets all form part of one system. This would be a serious defect; but it is readily avoided, either by the adoption of friction-contacts, or of contacts established by means of mercury. On the former plan, a spring, attached to the contact-piece O_1, would be placed as shown at O_1 X. But in this case the armatures themselves should be flexible and attached at one of their extremities, so as to give them an elasticity which might have the same effect as the residual magnetism of the electro-magnets—that is, to promote the movement from left to right, and to retard that from right to left. This greater tendency to the right than to the left would be the more necessary since the addition of the spring O X would prolong the contact to the left. If, on the other hand, mercurial contacts were adopted, the magnets would be placed upright, as shown in Fig. 2. This arrangement is the one I first adopted in my apparatus, and the one which was shown at the Palais de l'Industrie. It offers the advantage of dispensing with the separate relays D_1 D^2 D^3, the electro-magnets of which are replaced by the lower and inactive poles of the receiving magnets, to which a polarised armature is attached—so that the magnets in question take the part both of distributors and of relays.

Nevertheless I prefer the horizontal arrangement shown in Fig. 1, because in this case the armature is more actively attracted, being influenced at the same time by two forces, viz., that of the magnetism directly produced in one electro-magnet, and that of the magnetism developed by induction in the adjacent electro-magnet, which repels the armature.

The relays, whether separate from the reception electro-magnets or otherwise, are intended to direct a local current—the printing current—into a *combinateur* on the Baudot system, but simplified, since it is disencumbered from the mechanism intended to establish and to maintain synchronism. My "combiner" further differs from that of Baudot in having 32 contacts instead of 31, the 32nd serving for the passage of a negative current during the period of repose, or that in which the keys of the corresponding key-board are all raised. It differs from it, moreover, in being vertical instead of horizontal, and that it turns whilst the brushes (*balais*) remain at rest. These latter are all five arranged vertically; the type-wheel is fixed in the axis of the "combiner" and turns with it. The printing current consequently can only pass when the contacts corresponding to the letter to be printed pass beneath the brushes. At the same moment the letter is opposite the paper band.

But it is necessary that the printing current should be broken as soon as it has produced its effect, as otherwise errors would be certain to occur. Because, since I do not obtain synchronism, I cause my combiner to make rather more than one rotation in the period necessary for the electricity to return to its starting point after having traversed all the series of all the operators; for instance, four turns per second if in the same period the operators transmit three sets of currents, corresponding to three letters of their despatch.

Fig. 3 shows the device which I employ to cut off all access of the printing current to the combiner when its presence could only be a disadvantage. The wire of the fifth coil of the receptor, after traversing its relay and before passing to earth, returns to the coil P and magnetises its core. This magnetisation attracts the rod A B, of which the foot B is of iron; and this movement releases the spring C D, which comes into contact with O. It is through this spring and this contact that the printing current passes to enter the combiner; this entrance, therefore, occurs only at the moment when the movement of the polarised armatures has determined the path of the current; and as soon as it can make its exit by the friction-contact brushes, that is, only when the contacts corresponding to the letter to be printed are in the vertical line, the printing motion takes place. The hook E is connected to the armature of the printing magnet and is raised by the attraction of this armature. It raises at the same time the spring G D, and by this action breaks the printing current.

(Signed) Dr. Noel.

GALVANOMETERS.

BY J. T. SPRAGUE.

In some of the earlier numbers of *The Electrician* I gave a description of several forms of galvanometer, which I propose now to continue with reference to laws and peculiarities which have been a special study of my own.

The Sine Galvanometer.—The effort or pull of the earth upon a single magnetic needle, that is to say, the sum of the influence of the earth's magnetic field, is proportional to the sine of the angle of deflection from the zero line, its full power being exerted at 90deg. The influence or pull of the current varies in the inverse ratio, that is to say, the effort of the current, tending to move the needle, varies as the cosine of the angle of deflection, and is greatest at 0°. Hence in the tangent and other galvanometers the deflective power weakens as the resistance to it increases, and, therefore, the resultant influence of equal increments of current is rapidly reduced. In the sine galvanometer the needle is always in the line of utmost action of the current, because the coil of wire is made movable, so as to follow the needle in its deflection. Two results follow: 1. The current always exerts its full power, and, therefore, its result is collated purely to the earth's magnetism in the ratio of the sines of the angle, and, as it is no longer weakened by the deflection, there needs no allowance in the ratio of the cosine of the angle. 2. As the needle is always in the middle of the magnetic

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field of the wire, and never alters its position in relation to that field, any kind of construction or arrangement of the wires is equally available. As a consequence of this, and as the scale of sines is one of comparatively small differences, the measurement of currents, especially of those large in proportion to the power of the particular instrument, that is, producing deflections of over 45deg., is more accurately observed than with any other form of instrument. But the actual power of the instrument is of course reduced, because the actual deflections of the needle are proportionately increased, that is to say, if the needle of a tangent galvanometer moves to 45deg., and this instrument is then made to move on its centre and to follow the needle, the deflection will become 90deg., or generally the deflections which will be produced under these conditions will be such that the value of the tangent in one case is the same as that of the sine in the other.

Any galvanometer whatever may, therefore, be converted into a sine galvanometer by placing it on a stand movable on its centre. All that is required is to place a stop or a small weight on each side of one end of the needle or indicator, so as to limit the motion to a degree or two. As soon as current passes, the needle moves against one of these stops, then the instrument is moved gradually on its axis till the needle resumes the normal position on the zero line. A reading is now taken of the amount in degrees of arc through which the instrument has been turned, and the current is proportional to the sine of this reading. A single actual measure of the value, in any unit, of one deflection then gives the values of all readings from a table of sines, but, of course, variable with the strength of the earth's magnetism.

Ordinary Galvanometers.—The great majority of galvanometers are composed of two flat coils of wire placed side by side, with a space between them to allow the needle to enter the chamber formed by the interior of the coils. The power of the instrument depends upon the strength of the magnetic field produced by the wire with any given current; that is to say, upon the number of turns of wire which are effective. As to this, much misapprehension exists. Probably the great majority of electricians, if asked in what position a wire exerts the greatest power upon the needle, would reply, in the zero line, and close to the needle. Neither statement would be correct. I constructed an experimental instrument in which the conductor could be exchanged so as to constitute a single turn of wire having vertical distances of $\frac{1}{4}$, $\frac{1}{2}$, 1, and 2 inches from the needle, and be capable of sliding horizontally to any distance from the zero line. I passed uniform currents of 1 chemic and 5·4 chemics through this, and noted the deflections through a large range of positions. For experimental purposes, I assumed that the deflections were of tangential values (which is, of course, not correct, but useful approximately), and Figs. 1 and 2 show the resulting curves. The upper lines show the action of the larger currents, and Fig. 1 shows the effect upon a 2in. needle. (A chemic current is that which deposits 1 grain equivalent in 10 hours, an ampere being 5·68 chemics.)

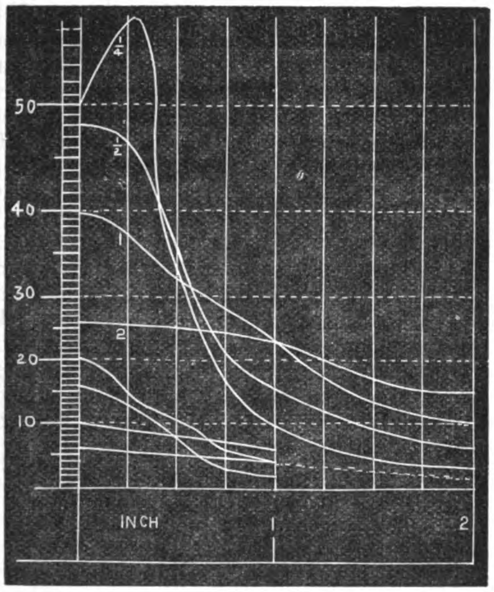

FIG. 1.

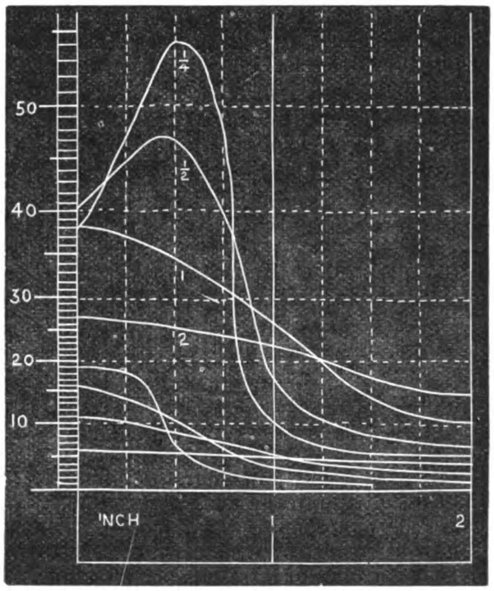

FIG. 2.

It is evident that the power of the current over the needle increases as it follows the deflection. In fact, as the wire is moved out from zero, the deflection increases as though the needle were being pushed out, until the wire is nearly over the pole of the needle. The figures show plainly that the wire is ineffective beyond a certain horizontal distance, which is smaller the nearer the wire is to the needle. The facts thus seen, the reason is obvious if we consider the magnetic fields generated. It is evident that these double coils constitute not one, but two fields overlapping each other, and the strongest part of each field is in the vertical plane of the middle of the coil. The consequence of this is that on the middle line of the two fields they have a weaker action upon the pole of the needle than they have as the deflection increases. The action of each point of the wire upon the pole varies, in fact, as the square of its distance. If, then, we consider the action at the zero line as representing the distance 1, the effect of the two coils will be $1 + 1 = 2$; but if the position is such as to halve one distance and double the other, we have the sum of the actions $4 + \cdot 25 = 4\cdot 25$, double the first power. Of course this is only a very rough mode of reckoning what could only be exactly represented by a very elaborate array of figures. As the vertical distance of the wire increases the overlapping of the two fields increases, and the action becomes more equal, as shown in the line of two inches. The gradual approach of the lines to the horizontal, as the distance increases, presents to the eye the action of the well-proportioned tangent galvanometer with large coil and small needle, in which the line of current would be a true horizontal line.

One object I have aimed at in galvanometers is to so construct them that the action of any of the horizontal sections should be equal, and such that it should vary as the number of turns of wire occupying that section. This can only be really accomplished on condition that there is no central opening, but a consideration of the several curves will show that it will be effected whenever all the lines representing current shall enclose an equal space. Therefore, as the wire occupying, say, the quarter-inch section, has a great power in the small deflections, that power can be reduced by extending the layer of wire to a distance at which its power is small.

Of course this diminishes the actual power of the instrument, because the object is not to use the wire so as to produce the utmost effect, but to obtain a particular result. In this way I have produced circuits of 1, 10, 100, 1,000 turns,

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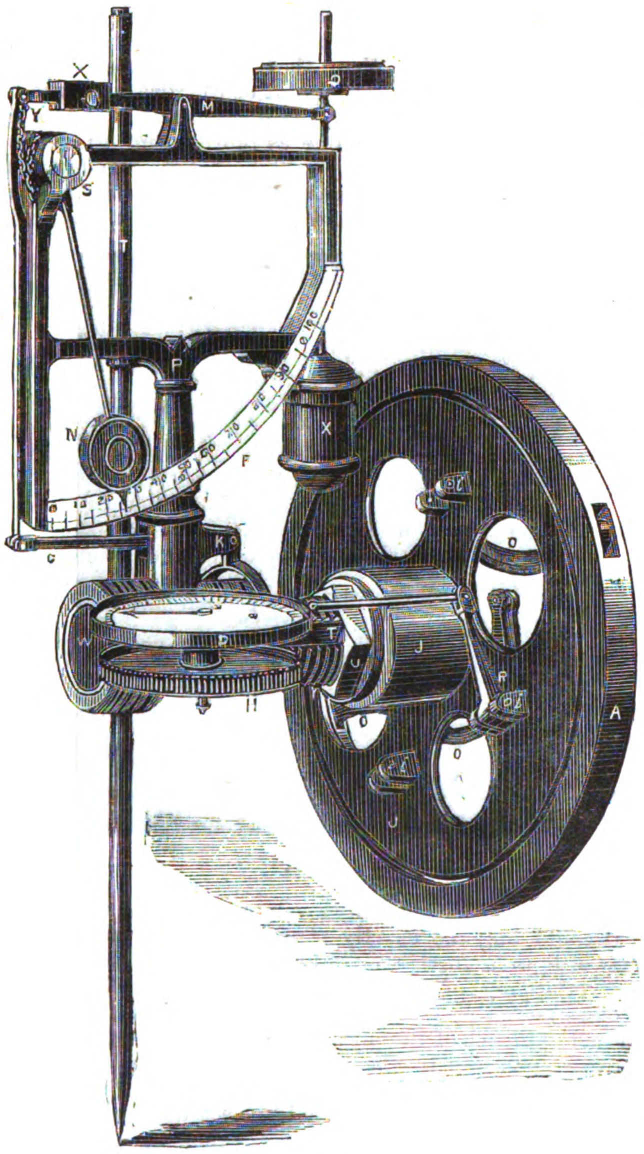
which, with those resistances in circuit, would each produce a deflection of 34deg. with a current from the same Daniell cell.

The difference in the curves in Figs. 1 and 2 shows the influence of length of needle, as, with the short needle, its pole undergoes less change of relation to the field as it moves and reaches that limit the earlier.

EMERSON'S POWER SCALES, OR DYNAMOMETER.*

BY JESSE H. LORD.

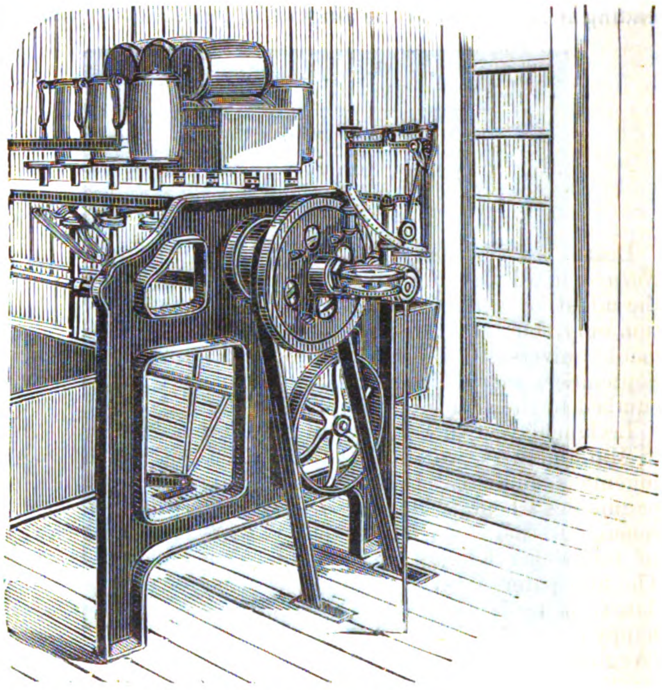
A number of attempts have been made to construct a power measurer which should give absolute results in foot-



Emerson's Dynamometer.

pounds; but most of them had some inherent defect, either in construction or application. Some have depended upon springs for efficiency, others have been intended for fixtures; most of them gave only relative results, and none of them were simple, portable, easily applied attachments. So many mechanics insist on a resort to the Prony brake as preferable to any and all so-called improvements. Yet a good dynamometer is unquestionably to be desired as a useful implement to the manufacturer, millwright, the leasor, and to the hirer of power. James Emerson, of Willimansett, Mass., has perfected a power scale that appears to possess all the requisites desired. Unlike most other power measurers, this demands no change in the machine or shaft to which it is applied, beyond the removal of one of the pulleys, if a tight and loose pulley are used, the pulley arms serving as means of propulsion or actuation of the power measurer. No springs are used on the machine, and all the movements are direct and absolute. No comparison with some other standard is required, as this machine gives absolute results instead of relative indications. In short, it is a power scales, and really weighs the "strain," "resistance," "friction," or "inertia," just as truly as the Fairbanks scales weigh the gravity of a load; and, like the Fairbanks scales, this may be considered a standard. The elements of its operation are speed of the machine, to be weighed or measured in feet, and resistance of the machine in avoirdupois pounds. Both these data are given by the appliance at the same time, and both are represented in plain figures. The result of the two multiplied together is the number of foot-pounds, which may be easily reduced to horse-power or its fractions if this is desired.

The larger engraving represents the power scale detached, and the smaller engraving shows it attached to a machine from which the loose pulley has been removed, and the tight pulley is made a loose pulley by having its set-screw slacked up or its key removed. The utility of this remaining pulley



Emerson's Dynamometer.

is to receive the driving belt, that the machine to be tested may be run at its normal speed.

The power scales have a disc of 12 inches diameter, to which, and its hub, all the attachments are made. It is secured to the end of the shaft of the machine to be tested by means of a split threaded sleeve with wedge-shaped jaws, formed to fit shafts from $\frac{7}{8}$ of an inch diameter to $1\frac{5}{8}$ inch diameter, and the adjustment requires but two or three minutes of the time of an intelligent workman. In fact, the adjustment of the power scales is similar to that of an object to be bored in the jaws of a lathe chuck.

In the larger cut some of the letters of reference may be of use; the levers O are pivoted at A in the disc, and connect with the arms of the driving pulley, or if the pulley has a solid web, with the sides of holes drilled through the webbing. The object is simply to give a rotary and "bearing" motion and resistance to the levers, which by bell cranks connect with an annular collar on the power scales, so as to actuate the lever C by the yoke K, that gives movement to the pendulum N. This connection between the rotating movement of the shaft of the machine to be tested, and the reciprocating motions of the pendulum and the lever C, is similar to that of the old-fashioned throttle governor of the

* From the *Journal of the Franklin Institute*, Sept. 1882.

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steam engine, and can be readily understood by all mechanics.

The marking scale beam of this power measurer is exactly like that of the Fairbanks scale in principle, being modified only by having a pendulum instead of a *pois*, and being a quadrant instead of a straight line. The letter shows how adjustment for perfect balancing can be made; G shows how weights may be added to increase the capacity of the power scales, this 12 inch size being capable, at 1,000 revolutions per minute, of weighing up to 25 horse-power, other speeds proportionally, and the letters W and H show the method by worm and gear of getting the number of revolutions of the machine to be tested. A staff, T, or a pointed bar, is used to rest on the floor to prevent the friction of the shaft from moving the pendulum and scale out of a perpendicular, and the dash-pot X combines with the adjuster-block X to prevent undue oscillation of the pendulum.

The total weight of this size apparatus is so slight that it may be carried easily under the arm, and its readiness for use is such that ten minutes is amply sufficient to apply and adjust it. No previous schooling or drill is required to enable an overseer or boss to apply this power scale, as is necessary in indicating a steam engine; and yet this apparatus is intended to do for the manufacturer, and for the hirer and the letter of power what the indicator does for the proprietor of steam-power, give the facts about the amount of power used and its cost; and this it does with accuracy.

GEORGE LECLANCHÉ.

Death has just taken away, says M. Hospitalier in *La Nature*, in all the fulness of his intellectual power, and in the midst of active work, a valuable man whom one invention only, but that an invention of prime importance, had made universally known. It was at Paris, on the 14th September, that M. George Leclanché died, having succumbed to the attacks of phthisis, at the age of forty-three.

Leclanché was an old pupil of the Central School des Arts et Manufactures, which he left in 1860 with a diploma of ingénieur-chimiste. He entered the laboratory of the Compagnie des Chemins de Fer de L'Est in this capacity, and remained there six or seven years; he left this post to follow his labours on peroxide of manganese batteries. The first patents taken out by Leclanché for porous jar cells date from 1867. In 1873 new patents were taken out by the happy inventor for his first cells with cylindrical composition (Aggloméré's) plates; the new cells with movable plates, the most in use now, date from 1876-78, and offer many advantages well known to our readers.

Leclanché was also actively engaged on electric clocks, and he devised a very simple mercury contact, very ingenious and certain, but as yet little known. In addition to this he devoted a portion of his time to his researches on batteries, the other portion being taken up with art, in which he was, both by right of birth and accomplishment, one of the most enthusiastic adepts. If the number of Leclanché's inventions was small, the success obtained by each of them was, on the other hand, as complete as possible, both in moral and material respect. The Leclanché battery, the manufacture of which is to-day almost a monopoly in Paris in the hands of M. Barbier, constitutes of itself quite an industry. It is actually, without exception, the most extensively used, and the invention of the telephone has given a new impetus, and opened up a fresh market for this battery, of which it is difficult to foresee the importance. Very modest in its first appearance, M. Barbier's factory now employs fifty workmen, and manufactures more than two thousand plates, at the lowest estimate, per day. The sale of the Leclanché cell last year had amounted to close on 300,000.

These few figures show what work and energy can do when devoted to one end and aim, when this end is good and one devotes oneself wholly to making it a success. Leclanché will have been the true populariser of electrical applications, for his batteries are to-day in every one's hands, familiarising the public with the wonderful effects of this mysterious power.

Under this title his memory will live in the mind of every electrician, and his life, too soon ended, will serve as an example to his younger comrades of our central school, of the spirit and aim of which Leclanché was the type.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The following are abstracts of papers communicated to this Association at its recent meeting in Montreal, Canada, in continuation of those we gave in a recent issue:—

The Nature of Comets.

Professor B. H. H. Vander Weyde, of Montreal, communicated a paper on "Some Suggestions on the Nature of Comets, with Recent Astronomical and Electrical Discoveries." Referring to the connection which has been traced to exist between meteoric showers and comets, to the behaviour of matter in the fourth state under the influence of electric currents, to currents in vacuum tubes acted upon by magnetic actions, and the fact that a perfect vacuum is the best non-conductor, he thought these suggested that the force which keeps the separate bodies constituting a comet apart may be a permanent electrical charge, which cannot escape from the interplanetary medium. Such an action as that described may be imitated with a bundle of suspended light bodies charged with static electricity. Such electrically charged clusters must be acted on by the sun. Practical experiments with Crookes's tubes, and the effects of magnetic and electric bodies on those suggest how the sun can cause changes in, and regulate the development of the tails of comets, which always manifest a solar repulsion analogous to that by magnets of the luminous streams in vacuum tubes.

Secondary Batteries.

In dealing with the subject of secondary batteries Mr. G. F. Barker said much attention is now given to the obtaining of the cheapest possible mode of producing the electric light. Much time and study had been given to the question by scientific men, and he himself had endeavoured to do something in the same direction. His object was to discover some plan for facilitating the reversal of the direction of the current in secondary batteries.

Dangers from Lightning Increased by Telegraph Wires.

Mr. Stephen S. Haight said that last year he had seen a house struck by lightning, and the eave plates completely destroyed. No other damage was done, and, beyond a slight shock, the family sustained no harm. At both ends of the house there was a lightning conductor, but neither of them bore any mark of the discharge. In front of the house was the pole of a telegraph line, stayed by a wire to the gate-post. The stay wire was melted, and the gate and gate-post damaged. A deep furrow also ran from the gate to the brick sidewalks, where it terminated in a hole. A tree in the course of the furrow was killed. He (the speaker) had no doubt that the damage was due to the stay wire, and, moreover, that the attractive power of the hemlock tree is greater than that of the deciduous trees.

TELEGRAPH WIRE WANTED.—The Great Indian Peninsula Railway are inviting tenders for the supply, amongst other things, of telegraph and fencing wire. Specifications and forms of tender can be had at the company's office, 3, New Broad-street, E.C., on payment of the usual charge. Tenders, addressed to Mr. Thomas R. Watt, managing director, at the above office, must be lodged in sealed envelopes, by twelve noon, on the 6th of October.

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THE ELECTRICIAN.

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BURGLARS AND ELECTRIC ALARUMS.

It is already a subject of comment among assiduous newspaper readers that at this advanced period of the dull season nothing has yet been heard of the sea serpent. Opinions differ as to his fate and whereabouts. Some say he has been scared out of knowledge by the naval cannonading off Alexandria; others argue that, his "special" friends being away with the British forces on Egyptian soil, he declines to show his face on the ocean; whilst a more prosaic conjecture has it that the "armed burglar" has scotched him with a revolver. Every one of these surmises has, doubtless, had some basis of fact, but as regards the closing weeks of September the "revolver" theory seems the more tenable. So much space has been taken up with details of the latest development in the art of burglary, and with correspondence relating thereto, that, allowing for war news, no room could have been found for our time-honoured friend even if he had condescended to appear. Everybody regrets the circumstance, for the most ardent searcher after a new sensation has no fancy for trying what a bullet-wound feels like. The sea monster was, at all events, harmless, and was generally amusing; the burglarious monster is neither. His advent, especially at this time of year, is therefore not merely unprecedented but alarming, and there is a general concurrence of opinion that he must be got rid of at all risks before the "big gooseberries" come in next summer.

We are glad to notice that practical electricians are bestirring themselves to assist the newspaper reader in this matter. Shops are springing up in many directions betokening the beginnings of a new industry. Electrical apparatus, not of the schoolboy sort, are being displayed for sale behind respectable plate glass fronts, and we may hope it is to be inferred from this that there is some largely increased demand for these useful appliances. Happily the interest aroused in electric lighting has extended to the capabilities of electricity in other directions, as is apparent from the little knots of people who curiously examine the wares which ingenious electricians have devised for them. There has already, we believe, been a run upon electrical fire alarums; and this latest agitation, provoked by the armed ruffian, will, it may be hoped, create a lively demand for the means of putting him to flight.

There is, we firmly believe, an excellent opening for a very large trade in this direction; and if a little of that capital ever ready to overflow the stream of electric lighting would find its way into the homelier but not less useful channel of electric alarums a remunerative return would speedily be assured. Enterprise is much needed as well; but enterprise would probably reply that without capital it can do but little, and that without public excitement little capital can be obtained. For this reason, although the occasion is a most disagreeable one to the timid householder, the accession of the revolver to the stock-in-trade of burglary is, perhaps, not wholly to be regretted. A perhaps exaggerated fear of personal violence will suggest measures for protecting property which is actually menaced. As we have remarked on a previous occasion, prevention is better than pistols, and, we may now add, cheaper too. A duel on the staircase where one combatant is in darkness and the other carries a light is a very unequal affair; and, on the whole, we should be inclined to back the candlestick as being the least threatening implement against any ordinary burglar armed or unarmed.

Moreover, the advocates of the pistol overlook one of its peculiarities. It does not go off of its own accord, except when we do not want it to go off; and it possesses no automatic power of divining the presence of midnight prowlers. The owner of the weapon will slumber in peace unless he is aroused, and it is not the business of the housbreaker to arouse him. At present, fortunately, he makes it his utmost care to disturb nobody; but even if the time should arrive when burglars may enter our premises like open belligerents, taking their chances of blazing and being blazed at, the domestic peashooter would be of little avail—nor the electric alarum either, for that matter. But, happily, we have not yet arrived at that stage of civilisation, and for some years to come an effective alarum will be the thing most dreaded by the lawless.

Nothing, probably, but inveterate conservatism has hindered the general adoption of some such precau-

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tions long ago; and it is this conservatism which the vendors of alarum systems have to count with in pushing their trade. Pushed, in fact, it must be, and this energetically. Not merely the advantages, but the means also, must be made familiar to the householder. At present he is quite mystified as to the latter, and imagines that elaborate paraphernalia would be necessary to effect the object desired. This, together with a decided preference for locks and bars inherited from his forefathers make him hard of conversion. He certainly will not fix the appliances himself; he would be just as likely to become his own bellhanger. They must be brought to his door, so to speak, and literally fixed there by the vendor.

Here, however, arises one of the problems which the mechanician will have to solve. The door is the natural entrance for everybody save the burglar; and there are so many other places by which he prefers to enter that the complexity of the arrangements, seemingly necessary, to guard them, will deter many people from adopting any. To surround the Englishman's castle with a network of electrical wires is as little to his taste as would be the arming of it with a battery of four-pounders. He wants simplicity, combined with certainty, and these our electrical and mechanical experts must be prepared to supply. If there are more entrances than one to a house there are usually not more than one or two to the movable valuables it contains. Some leading spot probably the intruders *must* pass on their way to them, and on the protection of this one spot the expert must concentrate his attention. Better still would it be to guard the approaches to the house, which, when duly considered, generally resolve themselves into one to two. Ordinary contrivances would amply suffice for the majority of cases; but special devices will often be needed, and these, too, the manufacturer must be ready and competent to undertake. Cut and dried patterns will not command a large market; but so soon as it is known that the electric alarum system can be adapted to any and every requirement, and that the proprietor himself need be put to no trouble in the matter, then almost certainly a considerable trade will be done.

One of the boons which practical electricians have conferred upon this class of industry lately has been the construction of simple, inexpensive, and durable batteries. We have seen some which are said to do duty for a couple of years without attention. The prevailing aversion to acids and messes is here sufficiently conciliated, and with a bell that will last for ever, wires that are indestructible, a small jar that can be put out of sight and out of mind for two whole years at a stretch, the most fastidious of men may be satisfied. The total cost, too, is a mere trifle.

That the adventurous burglar, with or without his revolver, will run the gauntlet of any tolerably efficient system of electric alarums is in the highest degree improbable. A little protection goes a great way with him—how little we need only examine our fasteners and locks to convince us. He knows he runs an occasional risk with even these poor safeguards, but the certainty of alarming the household if he approaches the coveted booty is more than he will knowingly face. With the general adoption of such precautions the profession of burglary would cease to be profitable, and, among other things, we might again enjoy in security and peace the reappearance of our missing friend, the sea serpent.

ELECTRIC LIGHTING FOR GLASGOW.—The Gas Committee of the Town Council have unanimously resolved to recommend that a provisional order enabling the council to light the streets by means of electricity be applied for.

CORRESPONDENCE.

RATIO OF WORK TO WEIGHT OF LEAD ELECTROLYTICALLY ACTED UPON IN SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: According to my experience, which is a somewhat extended one, the above ratio—if work be in foot-pounds, and the total weight of *lead* actually converted and reduced, at the anode and cathode, after the cell is "formed," be in pounds—is very closely expressed by the number 309,000.

If work be in kilogrammetres, and if the total weight of lead acted upon be given in grammes, the ratio in question becomes about 94·24.

What induces me to write this note is the fact that an experimenter has been vainly endeavouring to persuade a contemporary of *The Electrician* that 23,600 kilogrammetres of work may actually be obtained from a secondary battery originally containing one kilo. of "active matter," viz., minium.

It is convenient to consider *lead oxide* (PbO) as the "active" material in a lead secondary battery which has been duly "formed" and has been allowed to "run down." In this case the ratio of work in foot-pounds to total weight of PbO is very closely expressed by the number 286,900. And the ratio of work in kilogrammetres to weight of PbO in grammes is about 87·46.—Yours, &c.,

DESMOND G. FITZGERALD.

School of Telegraphy and Electrical Engineering,
12, Princes-street, Hanover-square.

TELEPHONIC TRANSMISSION OF MUSIC.

M. A. Niaudet contributes the following account of some recent experiments with the telephone as a transmitter of musical sounds to our contemporary, *L'Electricien*, of the 15th September:—

An interesting experiment, says M. Niaudet, was carried out a few days since between the circus (Hippodrome) and the offices of the International Telephone Company at 15, Place Vendome, Paris. The band at the circus, which plays in the daytime and the evening for the two daily performances, was listened to by a number of persons invited for the occasion to the Place Vendome. There were 96 telephonic receivers. Each auditor having two, 48 people could listen at the same time. We propose to give some details of the arrangements made by Dr. J. Moser to obtain this result. Through the kindness of the officials of the circus and those of the Société Générale des Téléphones, two wires which are in regular use by the circus management, who are subscribers to the exchange, were able to be used. But of these two wires, one was required for carrying on conversation, giving orders, &c., all of which are indispensable for the effective carrying out of an experiment like this between two distant points. There remained, therefore, but one wire for transmitting music by. The apparatus in the circus was thus arranged:—There were twenty-five microphonic transmitters mounted on a plank, slightly inclined from the horizontal and above the conductor of the band. The microphones were, of course, above the plank, protected from the dust by a light box. The plank itself was hung by four cords. The microphone battery was composed of three Reynier-Faure accumulators at first; the intensity of the current was indicated by a Deprez galvanometer placed in the circuit; it was kept constant by adding to these three accumulators another, then another, until the total number employed was nine. The result probably would have been obtained equally well with five Daniell cells, Reynier type, which have a very small resistance and are absolutely constant. The current is shunted through the microphones and then the 24 primary wires of 24 induction coils, connected in two series and 12 in

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a shunt. The intensity of the current was about 12 amperes. The 24 secondary circuits of the induction coils were grouped in series of four and six in a shunt. The resistance of each was 300 ohms, or together 1,200 ohms.

The line from the circus, 3,512 metres long (about $2\frac{1}{6}$ miles), ran into No. 66, Rue des Petits Champs, one of the offices of the Société Générale des Téléphones, where also the Place Vendome line was run to, this latter being very short. Communication was established by switches in the Rue des Petits Champs. The receivers, which were Ader's, were grouped 16 in series and 6 in a shunt. The reception was perfectly clear, and satisfactory to the auditors both of the midday performance and that in the evening. We do not think that it can be denied that the above is an improvement on the method of arranging the instruments adopted between the Opera House and the Palais de l'Industrie during the Electric Exhibition of 1881. At the one end there were 10 microphones, and at the other 80 receivers; but only one half of the receivers were in use at the same time; there were thus, in fact, four receivers per microphone with two wires, or 20 wires in all. The reduction in the number of the wires facilitates the process of laying them, diminishes the cost of the whole, and thus allows of more extended operations. M. Moser's experiment was made with a single wire, because the second was in use; but we do not pretend that in other cases only one wire need be employed; on the contrary, we think that it will generally be convenient to utilise two wires to avoid induction noises.

We may say, in conclusion, that the principal novelty in M. Moser's arrangement consisted in the combination in a shunt circuit of the 25 microphones, in the combination of the 24 secondary wires of the induction coils in series and quantity, as is done with the cells of a battery.

ELECTRO-METALLURGY IN BELGIUM.

The electrolytic works of M. Dupont have recently been entrusted by the Belgian Government with the production of eight sphinx-griffins (*sphinx-griffons*), which are to be placed on the cupola of the Palais de Justice at Brussels. Our contemporary, *L'Industrie Belge*, gives some details of the work entailed in the production of these sphinxes which may be interesting to our readers.

They will be 2 metres 30 centimetres high (or about seven feet), all alike, each of them being an exact reproduction of the model constructed by M. de Tombay, a Brussels sculptor. These grand efforts of decorative art will be executed in pure galvanic bronze. There is no thought, as has been erroneously stated, of covering a plaster cast with a sheathing of copper. The sphinxes will be produced in the same manner, and by the same process as was employed for the statues of Tinctoris, at Moelles; Jean van Eyck, at Bruges; R. P. de Smet, at Termonde; Louise-Marie Queen of Belgium, at Phillipeville; Jordaens, at Putte, Antwerp, and others, all of which left the workshops at Haeren between 1874 and 1880.

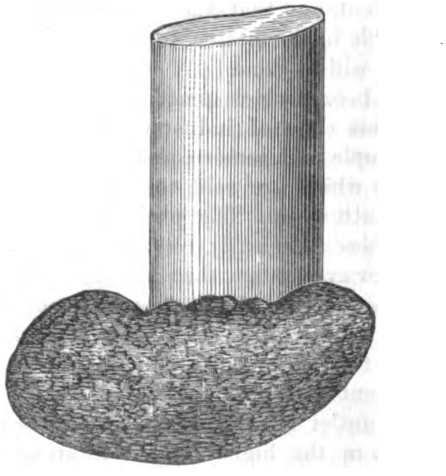
The original plaster model of the artist will be cast eight times. All the cavities will be filled with gutta percha, for which purpose at least 3,000 kilogrammes (roughly about 58 cwt.) of this resinous gum will be used. The castings submitted to the action of a powerful galvanic current in a bath with a saturated acid solution of sulphate of copper will be covered inside with a layer of chemically pure copper, which will follow all the curves and sinuosities of the casting, and exactly reproduce every detail, reaching a thickness of three or four millimetres (·118 to ·157 of an inch) after a continuous immersion of one month. The layer of copper thus obtained, when it has been separated from the casting, will be strengthened internally by a sheathing of solder of at least the same thickness. In order that all may be kept rigid and capable of resisting the great pressure of the wind to which the griffins, owing principally to the spread of their wings, will be sure to be exposed at the height which they are to occupy (about 75 metres, nearly 82 yards), a support of metal framework will be provided in the interior which will unite the whole work. This support will be strongly fixed in the plinth and solidly bolted in the stone arch destined to support the work when completed. The griffins will each weigh, when finished, from 800 to 900 kilograms (between 16 and 17cwt.), and will be in one piece.

These eight monster productions form the most important piece of galvanoplastic work that has hitherto been carried out in Belgium. It is the grandest piece of decorative architectural art accomplished in the whole world, if we except the groups Poetry and Music which ornament the *façade* of the Opera at Paris. It is known, indeed, that the greater portion of the external decorative bronzes of this group are the work of galvanic deposition, and that many art pieces in the interior of the opera, amongst others the two groups of Carrier-Belleuse, on the grand staircases, were carried out by the same process.

We congratulate the State on having entrusted this work to the Haeren workshops, and having thus given direct encouragement to a special industry, which it has been so hard to establish in Belgium. The eight griffins will be completed in about 10 or 12 months.

CONTACT MAKERS OF DELICATE ACTION.

In our last issue we gave a paper read at the British Association meeting by Professor Hele Shaw on this subject, the illustrations for which were kindly lent us by our contemporary *Nature*. Professor Shaw writes in the last issue of our contemporary correcting some errors in these illustrations. He says:—"I have allowed an error to creep into the sectional elevation of the contact maker described in your last issue. The bent wire merely *dips* into the capsule at D, and is separate from the wire, which passes up the tube. This latter wire merely forms part of the circuit, being connected with the terminal as shown in the plan. It should be noted that the plug K is only inserted when the contact maker is being moved about. Except when this is the case



End of Platinum Wire.

the mercury passes freely through the opening at M, and nothing but the *friction of mercury* resists the motion of the wire.

"Some remarks made in the discussion on the paper have led me to carefully examine the end of the platinum wire dipping into the mercury at D. It is shown (highly magnified) in the annexed figure. This end being softened, and no doubt brought to a welding state by the heat, of which the spark is the visible evidence, has, in rapidly beating upon the mercury, been apparently hammered into this shape. The nodules upon it are probably those referred to in books on chemistry as due to the expulsion of occluded hydrogen. The result shown in the figure, produced with a strong current (15 Grove cells) and a small wire, could in practice be easily prevented."

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NOTES ON ATMOSPHERIC ELECTRICITY.*

Before leaving for India in the end of 1876, it occurred to me that as almost nothing seemed to be known about atmospheric electricity in the tropics, it would be well if I could take with me the apparatus necessary for making observations on it. I accordingly communicated with Sir W. Thomson, who kindly obtained for me a grant from the British Association for a portable electrometer. This instrument I took with me, and the following are the results of the observations made with it. During the voyage a number of observations were made, but of those only two sets were of any special interest. The first of these was made in the Suez Canal, on December 22. At 8 a.m., at noon, and again at 8 p.m., the readings showed a negative electrification of from three to eight divisions of the scale, the weather being entered as "fine and bright," and the wind as "S. very light," "E. by S. light breeze," "E.S.E. light," respectively; while readings taken at 1:30 p.m. and 7:30 p.m. gave a positive electrification of eight divisions on each occasion. This has considerable interest in connection with some observations made at Madras.

The other set was made in the Red Sea during a rather violent squall. In this case the readings varied very rapidly from strong positive to strong negative, readings one and a half hour before having been + 18 divisions. The variations took place so rapidly that no quantitative observations could be made, and in a few minutes, when the squall had passed over, the readings were found to be as much as before + 17 divisions. In Madras a series of observations were made, extending from 17th January to 4th March, 1877. These were made at 8:30 a.m. and 6 p.m., and showed a wonderfully steady state of electrification, varying from a maximum of + 53 to + 19, with an average of + 33. The morning and evening readings usually agreed very closely. In every case the electrification was positive, and the weather very fine without any rain. During this time the electrometer had to be recharged every two or three days, an operation which, though very simple in this climate, is by no means so simple in a climate so moist as that of Madras.

After a time I found it impossible to continue the observations at all, and sent the instrument home to see if it could be in any way modified so as to suit the climate. On its return, after a long delay, I found it leaked as badly as before, and so rendered observations almost impossible. The reason is, doubtless, to be found in the circumstance that the air of Madras is not only moist but is also very full of small particles of salt, which are constantly being carried from the surf by the sea breeze. The glass of the jar soon gets coated with these particles, and no amount of simple drying will make the insulation good. That the fault did not lie in the jar itself I have tested since my return to this country, for I find that here the leakage is less than 1·5 per cent. per diem, while in Madras it was often over 30 per cent. per diem.

On account of these difficulties I was unable to make any long series of observations, but in July of 1881 I made a few that were specially interesting as being the only ones in which I have observed negative electrification in Madras, except during the thunderstorms. The observations were as follow:—

July	p.m.		Temp.	Reading.
5 ...	1	Strong land wind	94deg. F ...	– 74
6 ...	1	" "	" ...	– 16
7 ...	1	" "	" ...	0
7 ...	2:20	" "	" ...	– 15

In each case local showers within three or four hours. These observations are, of course, too few to form any theory upon, but those acquainted with the peculiar sensations produced by the land wind in Madras will feel that the point is worth investigation, and I hope on my return to Madras to be able to take with me improved apparatus with which to continue the observations.

* Paper read at the British Association meeting, Southampton, by C. M. Smith, F.R.S.E., &c., Professor of Physical Science in the Madras Christian College.

A RESISTANCE REGULATOR AND ELECTRIC HEATING APPARATUS.

The patent apparatus which we now describe and illustrate is the joint invention of Mr. Gustav Pfannkuche, electrical engineer, and Mr. R. E. Dunston, Assoc. Mem. Inst. C.E.

The regulator has been designed to maintain two circuits, either derived or otherwise, in a state of equality, or in any required ratio to each other. The object aimed at by the inventors has been to produce an instrument of great sensibility, and at the same time free from all delicate mechanism, which, however admirably arranged and constructed, is, nevertheless, from its very nature, liable to disorder and consequent breakdown. The construction and action of this regulator will be best understood by reference to the accompanying Fig. 1, in which A and B are two coils or solenoids wound on brass tubes and supported at the ends by brass frames to which they are attached by means of screws (in order that

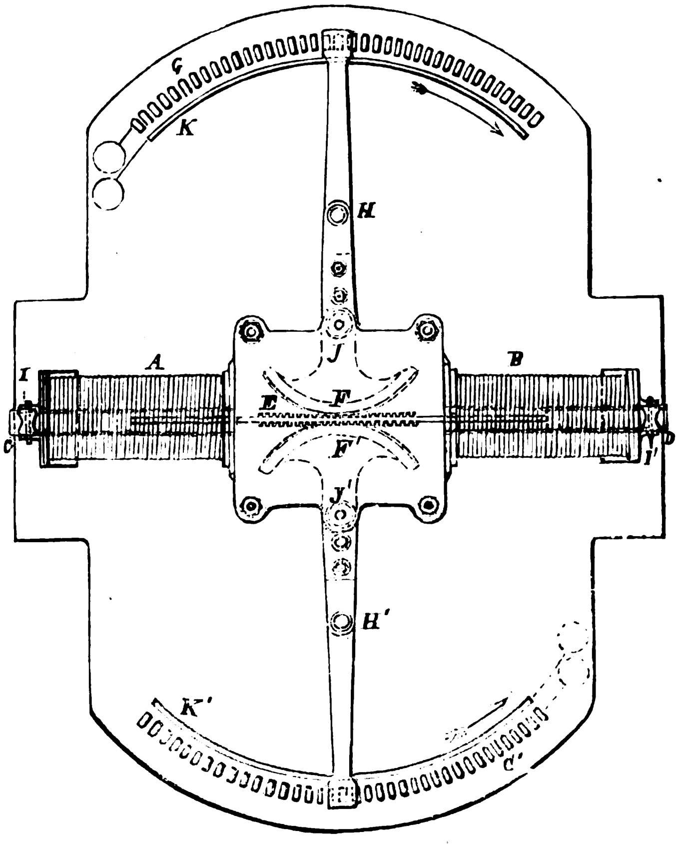

Fig. 1.—Resistance Regulator.

coils containing different numbers of convolutions and of larger or smaller wire may be inserted as required). Within these tubes are hollow iron cores, C and D—split longitudinally in order to prevent the induction of so-called Foucault currents —fitting loosely and supported at their farther ends on friction rollers I and I'. Their near ends are coupled together by a brass rod, the middle portion of which, E, forms a double rack, into which gear two toothed segments F and F', centered at J and J' on pivots. Attached to and insulated from F and F' are two arms H and H', travelling over the stops G and G', and the conducting strips K and K'. The stops G and G' are in connection with resistance boxes—to be presently described—with one of which each circuit is furnished. Let us assume two circuits, which we will call α and β, which are required to be kept in a constant ratio, α would be wound round A, and β round B. In the event of circuit α developing an increase of resistance circuit, β will take more than its due proportion of current, and core D will be sucked into solenoid B, the arms H and H' will move in the direction of the arrows, whereby circuit β, which is in connection with the

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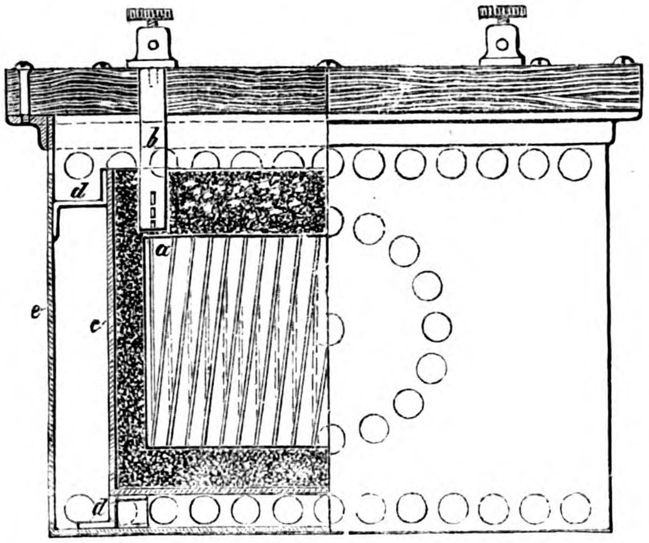
resistances G, will have resistance thrown in, whilst circuit α, which is in connection with resistances G′, will have resistance thrown out, and thus the two branches, α and β, will be maintained in an approximately constant ratio. It will be noticed that in this arrangement double speed is attained, and mechanical balance effected by means of using two arms.

It is fast becoming recognised, in spite of the superior economy, candle-power for candle-power, of arc lighting over any system of incandescent lighting, that the former is heavily handicapped, inasmuch as the lamps can at present



IG. 2.—Sectional View of Resistance Box.

only be burnt in simple series. The first and most important use, then, to which this system of regulation will be applied is to the burning of arc-lamps in parallel circuit. To what extent this sub-division can be attained has not as yet been ascertained, though we hope shortly to place the results of experiments on this point before our readers.

Any success, however, in this direction must prove of the greatest practical utility to the system of arc lighting. The rapidly-increasing favour with which the system of exciting the field magnets of a dynamo machine by means

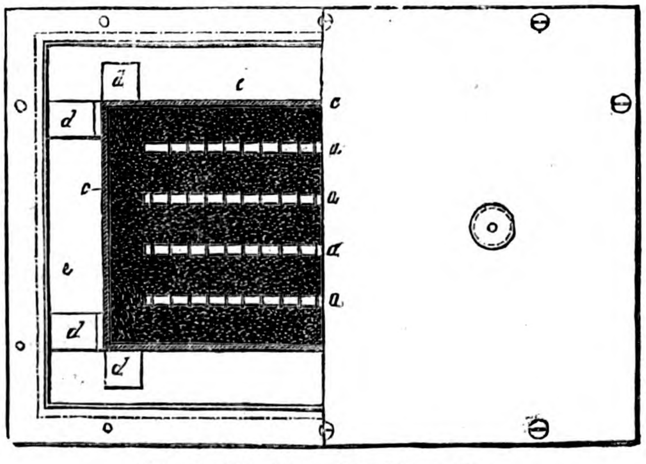


FIG. 3.—Plan View of Resistance Box.

of a branch of its own current, or "feeding" with a separate circuit, is looked upon, has also created a demand for some such simple form of regulation as that now treated of. In this case, however, in order to avoid the false economy of inserting resistance in the main circuit only one resistance box with one moving arm is required, namely, that in connection with the feeding circuit. The arrangement is such that, if the external circuit be maintaining arc lamps, any increase in its resistance results in an increased magnetic field; while for incandescent lamps running in multiple arc the arrangement is reversed, thus securing a constant electromotive force when lamps are turned on or off.

It will be seen from what has been said that the solenoids require to be wound with a number of convolutions inversely, proportional to the quantity of current to be taken by their respective branches, and that the power and consequent sensitiveness of the system is dependent upon the absolute number of convolutions.

The same inventors have also struck out a new line in the construction of their resistances. They have ascertained that, by embedding coils or frames of resistance in an incombustible heat-conducting insulating substance, wires of comparatively minute sectional area can be employed to carry large currents without danger of short circuit between the strands, or of break of circuit through fusion, and last, though not least, without danger of fire. Indeed, this last point is one which has been too long overlooked. Considering the reprehensible and slovenly way in which it is too often the fashion to insert resistances, it cannot be wondered at that insurance companies should begin to take alarm. Naked resistances, with the necessarily unavoidable chance of short circuit, are every wit as dangerous as naked fires; indeed, more, inasmuch as the character of the danger is so subtle that people unaccustomed to machine currents do not perceive it as such at all until the fact is forcibly borne home to them by the old adage, "where there is smoke there is fire."

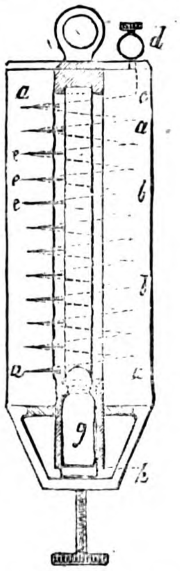


FIG. 4.—Regulator for Incandescent Lamps.

The box illustrated in Figs. 2 and 3 is of the following dimensions over all, 8in. by $6\frac{1}{2}$in. by $5\frac{1}{2}$in., contains a resistance of seven ohms, and is capable of carrying a large current. Its construction is as follows:—(*a a a*) are slabs of slate, round which are wound the resistance wires, the ends of which are made fast to the terminals on the wooden cover of the box; these slabs of slate are inserted in a rectangular box (C) of thin sheet iron, which is then cast full of composition. This iron box is in its turn surrounded by a perforated iron casing, from the sides and bottom of which it is kept equidistant by means of distance pieces (*d*), thus allowing a free current of air to circulate round the heated inner box, and carrying off the heat as soon as generated, at the same time preventing any possibility of fire from the contact of inflammable substances with the inner box. It will be seen that, with a given current, the heat generated will be that due to the resistance of the fine wire, whilst in this case the radiating surface has been increased from that of the wire to that of the inner box. The radiating surface may be still further increased by means of vent holes placed in the composition between the coils. The connections to terminals are made of such a sectional area as to preclude the possibility of heating, whilst the junctions with the fine wire are embedded in the composition. It follows that even if it be possible to fuse the fine wire there can be no danger or interruption of the circuit. This leads us to the interest-

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ing, though as yet little considered, question of heating by electricity, and the inventors have designed an urn fitted with a heater constructed on the same principle; and they are also engaged on elaborating a system of heating railway carriages, the details of cost and construction of which will shortly be made public. Figure 4 represents an ornamental adaptation of the same principle to the regulation of incandescent lamps. The figure is a section of a pendant resistance in which *(a)* is a cylinder of glass, in which is rolled the spiral *(b)* of fine wire, one end of which *(c)* is attached to the terminal *(d)*, whilst the other end, together with many graduated points on the spiral *(e e e)*, is in communication with the inner tube, in which a column of mercury can be caused to rise and be maintained at any required point by means of the bag *(g)* and plunger *(h)*, the mercury being also in connection with the ingoing terminal. Its action is as follows:—When the mercury is lowered quite into the bag the circuit is broken, when the piston *(h)* is screwed up until the mercury makes contact with the lowest point of the spiral, connection is made, but the whole resistance of the spiral is thrown into the circuit of the lamp or lamps, of which it forms a part. By screwing the plunger until the mercury is at the top of the tube all resistance is thrown out, and the lamp burns at full power, at intermediate points at half power, &c., as may be desired, the light being thus regulated or extinguished at will as easily as in the case of a gas jet. The inventors also construct a pattern suitable for a wall ornament, in which a flat slab of glass is substituted for the hollow cylinder, and a sliding contact moving over stops takes the place of the mercury column.

MOLECULAR STRUCTURE OF METALS.*

BY S. KALISCHER.

Although most of the metals are known in the crystalline form, yet it is generally held that they have lost their crystalline character when rolled out into foil or wire, although no observations have been made on this point. The author in some former experiments (preceding Abstract) found that non-crystalline zinc foil becomes crystalline when heated to 150deg. Similarly the crystalline structure of cadmium, which is not altogether lost in the process of hammering out, becomes more manifest when the metal is heated to 200—280deg., and subsequently etched by copper sulphate solution. The same observation holds good with tin. Iron and copper show traces of crystalline structure when left in contact with nitric or hydrochloric acid, but the best result is obtained when the plates are made the positive electrode for the electrolysis of potassium, ferrous, or copper sulphate or nitrate. Specimens of brass containing 36—66 per cent. of copper displayed a crystalline structure when made the positive electrode of solutions of copper sulphate or nitrate. Specimens of pinchbeck were also recognised as crystalline. In the cases mentioned above, the galvanic current as such does not produce the crystalline state, but the solvent power of the electro-negative constituent of the electrolyte, for it is observed that metals which do not show any crystalline appearance when corroded by free acids, or solutions of salts, do not show it under the influence of the electric current.

Lead foil is crystalline, silver foil becomes crystalline when heated to a red heat, as shown by the action of concentrated nitric acid. Gold foil shows crystalline structure when heated, and subsequently etched by warm aqua regia. The crystalline appearance of platinum, when warmed with aqua regia, has previously been observed by Phipson and Noble, even if not previously heated. German silver shows no crystalline structure when made the electrode of a copper sulphate solution, but the crystalline character becomes manifest when the metal is corroded with dilute nitric acid. No crystalline structure could be recognised in nickel, aluminium, or magnesium cobalt.

From these experiments it appears that metals whose crystalline structure may be detected when rolled out into foil are also crystalline when cast. The author has accordingly examined bars of copper, brass, steel, bronze, tin, zinc, and cadmium, and has detected by the methods described above a crystalline structure; aluminium and nickel, however, show no crystalline structure.

These facts are of great theoretical importance as regards the difference of electric conductivity of metallic wires, for it has been shown by Siemens and by Matthiessen that the conductivity of wires of silver, copper, platinum, brass, and gold is increased from 1—10 per cent. by heating. From the author's experiments, it follows that this increase of conductivity must be attributed to a change of molecular structure.

The author has examined the conductivity of non-crystalline and crystalline wires of platinum, gold, silver, brass, copper, and zinc, and has confirmed Matthiessen's results. In the case of cadmium, sometimes an increase, sometimes a decrease, and at other times no change was observed in the conductivity. In the case of iron and steel no difference was observable.

These experiments give as result that the crystalline is the natural structure of both metals, but by mechanical processes some metals lose this structure easily, others with difficulty, and others hardly at all, but assume it again under the influence of heat; and increase of electric conductivity is involved in this change of molecular structure.

* Abstracted from *Ber.*, 15, p. 701, for the *Chemical Society's Journal* for August.

EXAMINATION QUESTIONS.

Questions set at the recent examinations of the City and Guilds of London Institute for the Advancement of Technical Education.

18.—ELECTRO-METALLURGY.

Ordinary or Pass Grade.

1. Describe what physical and chemical changes occur when iron is immersed in a dilute solution of blue vitriol.
2. How would you recover the silver from an old silver cyanide plating solution?
3. State the chemical changes which take place on adding sulphuric acid (also hydrochloric acid) to an ordinary silver plating liquid.
4. What is the object of adding carbonate of potash to the ferro-cyanide of potassium in making potassic cyanide?
5. State the effects of rise of temperature upon the conducting power of metals and upon that of electrolytes.
6. How would you regulate the amount of current passing through a plating solution without disturbing the electrolyte, the anodes or articles in the vat, or the battery?
7. Give the atomic weights of hydrogen, oxygen, copper, and silver.
8. Give the molecular weight of concentrated sulphuric acid.
9. Give the chemical formula for argento-cyanide of potassium.
10. State the meaning of the term "an ohm."

Honours Grade.

1. Explain what physical and chemical changes occur in the process of "quicking" copper articles by means of a solution of mercuric nitrate.
2. Describe the process usually employed in making a copy in electro-copper of a plaster of Paris bust.
3. Describe the method of electro-silvering steel knives.
4. Describe the method of forming and managing a "bright" silver plating solution.
5. How would you ascertain the correct percentage of cyanide of potassium in a specimen of that salt?
6. State the chemical and physical changes which take place on adding a solution of cyanide of potassium (also one of chloride of sodium) to a solution of nitrate of silver.
7. Give the electro-chemical equivalents of zinc, hydrogen, copper, and silver, and state the weights of hydrogen, copper, and silver, which, according to theory, would be electrolytically deposited by the current evolved by the consumption of 100 parts of zinc in each cell of the battery.
8. How much cyanide of silver can be obtained by the decomposition of 100 parts of argentic nitrate.
9. Give the formula and molecular weight of argento-cyanide of potassium.
10. State the meanings of the terms "an ampere" and "a coulomb."
11. Make a sketch of an electro-plating vat and its contents.
12. Describe all the modes of producing "coloured gilding."

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A GUIDE TO PRACTICE IN THE SUBMARINE CABLE TESTING ROOM.

II.

The diagram which accompanies this (Fig. 1) is intended to represent one form of Wheatstone bridge arrangement, in which everything necessary for taking the "bridge" test is given excepting only a small commutator for reversing the direction of the current when one end of the cable is put to earth, or is beyond the operator's reach. We have also omitted a battery commutator or shifting attachment, marking only two terminals for the poles. It is usual to have the means of testing with varying numbers of cells; thus there would be one small brass plate to which the wire from the copper pole is connected, and two or three separate plates for zinc leads, or leads from the zinc pole of two or three different cells, as, *e.g.*, from the fifth, tenth, &c., so that by placing a plug in the right place the required number of cells is introduced.

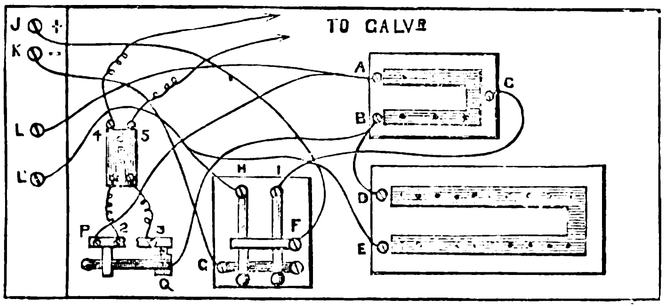

FIG. 1.

The leads shown in the diagram will not be visible to the operator as they pass under the board, their ends only coming up through it and being attached to the terminals. The leads from the core and cable ends of the section to be tested are connected at L and L'. Supposing the *cable* end at L the course would be traced through its lead to its real extremity, through its coils in the cable tank and through the sheathing machine, then through the core coiled in *its* tank, and back through the other end to L'. For the same reason that these portions of the arrangement are omitted we are obliged to omit the galvanometer—space would have been wasted. The same reason applies to the battery leads.

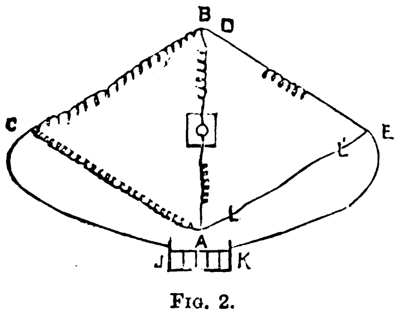

FIG. 2.

The other diagram (Fig. 2) represents the familiar theo- and to impress on the learners' mind the course and distribution of the current. The governing conditions of the arrangement are these:—No effect is produced on the galvanometer, 1st, if in each of the four resistances the amount is the same—say 10 in each. 2nd, if in the two left hand branches we have the same resistance, *e.g.*, 20, and in the other two resistances equal to each other. 3rd, if the two left hand branches bear the same proportion to each other that the two opposite branches have; or, what comes to the same thing, if the two top resistances have the same ratio that the lower ones have. This last condition clearly includes the two first.

In following out the circuits we shall at first describe the retical illustration of the circuits, and is given here to afford means of comparison with the more practical figure, course as if assuming that there are two totally different currents, a positive and a negative, for the purpose of clearer explanation discarding the theory of one current only; but this latter, the most correct view of what we are obliged to call a "current," regards it as merely running in either direction from the positive pole as we direct it. Although we have marked the points J and K for the poles of the battery, we need only start from F and G, key terminals, since the absolutely real poles are not there, but at the junction of the battery wires with the plates or elements. If the key H is put down, thus connecting it with the bar below, the current will run as follows:—Tracing in one direction—it starts, say, from E—dividing there, and passing to L', one end of the cable, through this, and through the tanks, &c., to the other end at L, and thence through the arm A C, where it meets the other pole of the battery. At the same time, from the point of division E it runs through the variable resistance to D, and through the arm B C to the same pole. But at the points A and B on each journey it passes through the galvanometer and affects it according to the arrangement of the resistances. If the other key, I, be put down instead of H, the current divides at C, and passes both ways, as we have just seen, only in reverse direction. The double current theory does not assume that the two currents are so totally distinct that they have a separate existence; nor can the course of one of them, for example, be traced from E through the whole four resistances back to that point.

In saying that the current divides at E, one portion going one way and the other portion on the other side, we use an expression which must not be literally accepted without full comprehension of the ruling conditions. It will be seen that the figures we have imagined as the several resistances in circuit amount to very different sums on either side, 50 and 100 at the top, against 10 and 20 at the bottom (Diag. 2); so that viewing each as a separate part of the path to be traversed there would be 150 units of resistance on one side and only 30 on the other. At first sight a beginner might be puzzled to understand that the effect on the galvanometer is *nil*, when there appears such inequality of resistance, knowing, as he probably would, that an electric current is inversely proportional to the resistance it encounters in its conductor. (We know for a fact that this point is the cause of the main difficulty experienced by learners, and it may not be easy to remove it at once.) It is true that the conditions governing either branch of the circuits do really depend upon the amounts of the resistances and regulate the indications of the galvanometer. But it is not the total amount in one or other branch which gives the result, nor even is it the proportion of one total to the other. The resistances must be regarded as made up of two portions in each branch—one in each arm—and the effect on the galvanometer will depend on the arrangement of the resistances on either side of the point at which its coils are connected or placed in circuit. To arrive at a perfect balance, as above stated, we must arrange the resistances so that (Fig. 2) the amount in E A shall bear the same proportion to that in A B that A C does to B C. Or, as it has been well put by an established authority on these matters, "If the point B in the branch E B C be at the same distance along the course (of resistance) that the point A is in the branch E A C, no current will flow through the galvanometer," or, in fact, from B to A. If the upper branch have 150 ohms, and the point B be at the 100th, and the lower branch have 30 ohms, and the point A be at the 20th, no current will run across, because both B and A are two-thirds of the whole amount of each distant from E. This brings us to the duty of explaining how these results come about—for the point E is one pole of the battery, and the laws of the electric current regulate the whole matter.

The theory of the Wheatstone bridge has been thoroughly explained, and its proofs worked out in several publications, which should be studied. It is, however, necessary to the carrying out of our object to say a few words in the same direction; putting the matter as familiarly as possible to aid the student in understanding what he will find in the books. Fleeming Jenkin's "Electricity and Magnetism" contains a complete explanation of the "bridge," while Kempe's "Testing Treatise" well describes its employment.

While discussing the object and meaning of this test, it is not our part to make more than a few remarks, wishing only

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to act as a guide to the novice, who must turn to the text-books and study the explanation of Ohm's laws.

An electric current encounters resistance in every conductor through which it is passed. The power which urges it forward is the electromotive force. The strength of the current, or the quantity passing in a given time, is directly as this force, and inversely as the resistance in the circuit. Electricity in action is electricity of (a certain) potential. This word means, as nearly as we can put it, a power for work and a tendency to do it as against some resisting force. It will not seem difficult to conceive that undeveloped electricity has no potential, as being, so to speak, incorporated with matter, the potential of which, in other words the earth potential, is zero or nothing. If a conductor be positively electrified, positive electricity will flow from it to earth if it is connected to earth. Conversely, electricity would flow from earth to a conductor in contact negatively electrified or at a negative potential. And if a circuit be formed by a conductor from one pole of a battery to the other, the point of no potential will be at the negative pole. Positive or negative electricity is electricity of positive or negative potential; so, where there is no difference of potential there can be no true current. The potential P is the measure of the electromotive force, and has also relation to the force of resistance to the electrical action; we can, therefore, understand that the potential will be highest at the source, and falls regularly to the zero point. From what was said above, namely, that the quantity passing in a given time, Q, is directly as the electromotive force E, and inversely as the resistance R $\left(\text{then } Q = \frac{E}{R}\right)$, we may substitute the potential P for E; then $Q = \frac{P}{R}$ and $P = Q\,R$, that is, the potential at any point in the circuit is equal to the quantity passing in a given time multiplied into the resistance at this point. From this we shall be able to see why, if the resistances in the bridge be arranged with the ratios already mentioned, no current will pass across from B to A. Let us illustrate this in the case of the two branches E B and E A. Supposing the electromotive force to be 1,000 (any value will do for our purpose), the resistance at E for the upper branch is 150, and for the lower 30. We desire to know what is the potential at the two points A and B. Since $Q = \frac{E}{R}$, we have $Q = \frac{1{,}000}{150}$ for the upper, and $Q = \frac{1{,}000}{30}$ for the other. Substituting P (potential) for E, then $Q = \frac{P}{R}$ and $P = Q\,R$ for both branches. Take the upper one $P = \frac{1{,}000}{150} \times 50$ (for this is the amount of resistance at A) which $= \frac{1{,}000}{3}$. In the lower branch $P = \frac{1{,}000}{30} \times 10$ (which is the resistance at B) and this $= \frac{1{,}000}{3}$. Thus, the potential being the same at A and B, no current can pass. There may be better ways of explaining the subject, and, doubtless, the description could be more strictly in accordance with the latest views of electrical science but if the student will try the way we have here followed, he can improve his knowledge by studying higher authorities afterwards.

The ratios for the several branches may be of any value theoretically, but when we come to practice we must be guided by the circumstances of the case. The ratio to be fixed for the two arms of the balance depends upon the resistance to be measured, and upon the resistance of the galvanometer employed; for example, if the resistance of the cable be small, the other three should also be small. Generally speaking, 10 units in one arm and 1,000 units in the other arm is considered a most convenient proportion. The varying resistance—that is, the arm E B (Diag. 2)—amounts to 10,000 units; thus, with this ratio of 1 to 100, only 100 units can be measured; if we lessen the ratio until we have equal arms, or, say, 100 or 1,000 in each arm of the balance, we can measure 10,000. For resistances higher than this the ratio must be reversed, and then the amount of resistance in the variable arm is multiplied instead of being divided by the ratio. If A C be 10 and B C 50, then the variable resistance is five times that of A E. Having got a balance, we must *divide* E B by the ratio to know the resistance of A E. But if B C were 10 and A C 50, then we should have to *multiply* E B by the ratio to find the value of E A.

We have endeavoured to shorten as much as possible the theoretical part of our subject. In the next number we shall enter on the more practical side, which is most needed by the learner at the outset of his course.

ATTRACTION AND REPULSION DUE TO SONOROUS VIBRATIONS.

BY A. STROH.

In our last volume (*The Electrician*, Vol. VIII., pp. 405 and 421) we gave some account of Mr. Stroh's experiments in relation to the phenomena of attraction and repulsion by sonorous vibrations, and the resemblance they bear to magnetic attraction and repulsion, as described in a paper read by him at a meeting of the Society of Telegraph Engineers and of Electricians on the 27th April last. It will be in the recollection of most of our readers that the interest aroused by Mr. Stroh's paper was so great that he was asked by the Society to repeat his description at a further meeting. This he did, and supplemented his first paper by a description of several further experiments which had not been mentioned at the April meeting. We have recently received an account of these supplementary experiments from Mr. Stroh, which we reproduce below.

Mr. Stroh began by replying to various questions which had been addressed to him at the April meeting. He said:—

Professor Guthrie's question as to whether *attraction* were changed into *repulsion* by the removal of one of the vibrating membranes to the extent of half a wave length is one to which I gave some attention at the commencement of my research. It is perfectly reasonable to expect such an effect, and I have alluded to it in my paper, but being at the time in search of other effects, I did not further pursue my investigation in that direction.

Mr. Preece was quite right in suggesting that two membranes standing opposite each other and vibrating in opposition to one another, as shown in Fig. 8* of my paper, might be said to be in *opposite* phase, instead of being in the *same* phase, as I have described. But I think we must in these experiments look upon the *effect* more than the *cause*, and when both membranes produce simultaneously alternate compression and rarefaction of the air near them, whatever be their position towards each other, we must look upon the vibrations as being in the *same* or *like* phase with regard to the medium between them.

I understand that Mr. Preece's suggestion arose from the desire to make the analogy between the two sets of experiments *perfect*, but the last experiment described in my paper shows that this cannot be done.

In this experiment, which I consider an important one, for in it two effects are combined, the little disc (see p. 422, Vol. VIII.) places itself *parallel* with the axes of the drums, whose membranes are vibrating in like phase, while it turns at *right angles* to the axes between two similar poles of magnets. In both cases it is *repelled* from the central or axial position.

Were we now to reverse the order of things, and call the phase of vibration of two membranes, as represented in Fig. 30*b*, the *same* or *like* phase, and compare it with two similar poles of magnets, then we should obtain certainly a position of the disc at right angles to the axes of drums or

* The numbers of the figures here referred to are those corresponding with the diagrams as they appeared originally in *The Electrician*, and not with those now published in the *Journal of the Society of Telegraph Engineers and of Electricians*.

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poles in *both* cases; but, between the vibrating membranes, it would be *attracted* towards the axial position, while between magnetic poles it would be *repelled* from the axes of the poles towards the position X X, Fig. 31*a*. Therefore, by setting one difference right, another would appear, and the change of terms would not help us in any way.

Professor Foster asked, very pertinently, what would take place when the phase of vibration of the two membranes was neither the *same* nor *opposite*, but *quarter* phase. My apparatus, as at present constructed, does not admit of the pro-

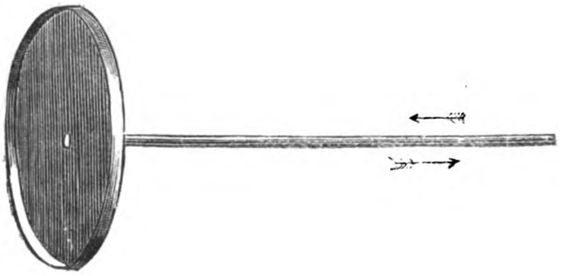


Fig. 32.

duction of this effect, but I have not the slightest doubt that, in the case mentioned by Professor Foster, there would be neither *attraction* nor *repulsion*.

All the experiments described in my paper, and which I have shown this evening, are such as can be compared with corresponding magnetic experiments; but there are others which will not compare with magnetism, and which are nevertheless interesting in connection with the investigation.

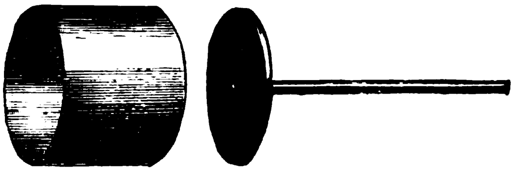


Fig. 33.

For instance, I have shown by the two card-board discs, represented in Fig. 19 (Vol. VIII., p. 421), that we obtain apparent *attraction*, caused probably by the momentum of the expelled air creating a partial vacuum as described; but, if by some means or other I prevent this momentum taking place, say by placing a flange or rim round the disc (shown in Fig. 32), the conditions are entirely altered. If I move such a disc with a flange to and fro in front of a suspended disc, in the manner described in the experiment Fig. 19, we obtain *repulsion*, while as soon as I remove the flange from the disc we have *attraction* again, as before.

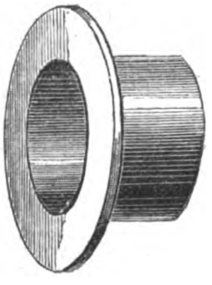


Fig. 34.

This experiment may be varied by taking a piece of brass tubing of about 9 centimetres in diameter, and about 7 or 8 in length, into which fits loosely a wooden piston with a rod, as shown in Fig. 33, and presenting one end of the tube to the suspended disc (Fig. 19) while moving the piston within the tube to and fro. Then the tube acts in a similar manner as the rim or flange in the previous experiment, and *repulsion* is the result; but by placing a flange or disc of about 14 centimetres in diameter, as shown in Fig. 34, on the end of the tube which is presented to the suspended disc, *attraction* is again obtained. It is worth noticing that the flange in this experiment forms a flat surface at *right angles* to the axis of the tube or the piston rod, while in Fig. 32, where the *opposite* effect is obtained, the surface of the flange is *parallel* with the axis or rod.

A similar experiment may be made with the drum and vibrating membrane. We have seen that a single vibrating membrane will attract a disc, D, Fig. 10, but when a short piece of tube is placed over the drum, so that the end of the tube projects beyond the drum and membrane to the extent

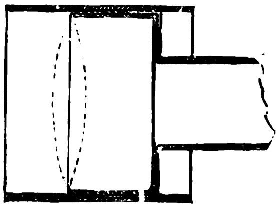


Fig. 35.

of a few millimetres, as shown in Fig. 35, *repulsion* of the disc D is the result, while a little flange of three millimetres in depth (shown in Fig. 36), when placed on the end of the tube, will have the effect of converting the repulsion into *attraction* again, as before.

I may be excused here for indulging in a little speculation, viz.:—We are all aware that there is no substance known at present which will insulate magnetism, or, in other words, which the magnetic lines of force will not completely penetrate. If we had, however, such a substance, and were able

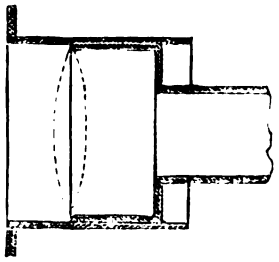
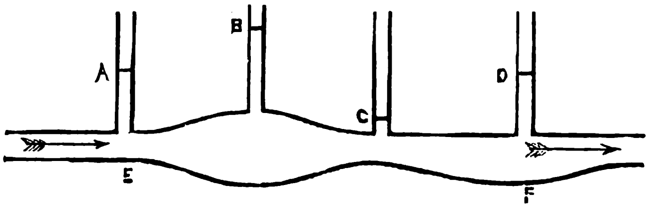


Fig. 36.

to make a tube of it, and place it over the pole of a magnet, in the manner shown with the drum, and thereby cause the lines of magnetic force to be altered or diverted into a different direction, *perhaps* (and I only venture to go so far as to say *perhaps*) we should obtain similar results with a magnet as those I have just shown with the disc and the vibrating membrane.

In the discussion which followed, Professor W. G. Adams, F.R.S., made some interesting remarks, which we reproduce. He said:—We know well that Mr. Stroh is always exceedingly clever in carrying out experiments to illustrate any subject that he takes in hand, and to-night he has quite succeeded, and has given beautiful illustrations of vortex motion in liquids and in gases. He has shown us the com-



plete analogy between the motions of gases and the motions of liquids, as shown by the experiments of Professor Bjerknes (which many of us had the pleasure of seeing last year in Paris), when they are set in motion by vibrating discs. He has shown us also the close analogy between the motion of such vibrating discs in the presence of liquids or gases, and the motion of a magnetic needle in a

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magnetic field. I would like to make a few remarks with reference to the cause of these apparent attractions and repulsions of the vibrating discs in Mr. Stroh and Professor Bjerknes' experiments, and to draw attention to the relation which these experiments have to the beautiful experiments of Mr. Froude, whereby he proved some years ago that, when a fluid is in motion, but with different velocities in different parts, the whole amount of energy of motion of the fluid being a constant quantity, where the velocity is greatest the pressure of the fluid is least. From the principles of conservation of energy, we should expect that, in a fluid in motion, if part of the energy is spent in increasing the velocity of the moving particles, there must be less potential energy or diminished pressure. Mr. Froude showed this experimentally by allowing a stream of water to flow through a pipe of varying diameter in different parts. Where the pipe was contracted, and therefore the velocity of flow increased, the pressure was diminished, and where the pipe was largest, there the velocity of flow was least, and the pressure was greatest. Thus, if E F be a pipe through which a liquid is kept continually flowing, and if tubes A B C D be inserted at various points, the height of the liquid in these tubes will indicate the pressures at the several points, and these heights will be found to be least where the pipe is smallest, *i.e.*, where the velocity is greatest. Now let us see what bearing this principle has on Mr. Stroh's experiments. If we take the case of the vibrating disc, which is attracted when the back of the hand or a disc not in vibration is presented to it, immediately in front of the centre of the disc, the changes of velocity of motion of the fluid are the greatest, and the mean square of the velocities has its greatest value, and hence the average pressure in this position is less than in other parts of the fluid. In going out from the centre of the disc in any direction, the average velocity diminishes, and, as the energy of motion depends upon the square of the velocity, and will therefore be the same whether the motion be backwards or forwards, the average pressure will gradually increase until we reach that portion of the fluid which is not in vibration. The external pressure on the tube and support of the disc being greater than the pressure immediately in front of the disc, the disc will move forward.

Take, again, the case of attraction of discs at the ends of two tubes placed opposite to one another, and both vibrating inwards or both outwards at the same instant (discs which Mr. Stroh describes as being in the same phase). In this case, in the experiment with glycerine and a coloured liquid, we saw (and I hope members noticed this point in the experiment) that the vortices were moving with different velocities in different parts of the four quadrants in which the symmetrical states of motion were set up. The velocities were greatest immediately in front of the discs where the threads of coloured liquid became suddenly drawn out, and hence we should expect that these were positions of least pressure, and that the resultant pressure in front of the discs is less than behind them, and, consequently, the discs will move towards one another. The thread of coloured liquid came slowly up along the face of the disc towards the centre, and the velocity gradually increased to its greatest value as the thread bent round to move in a direction perpendicular to the faces of the discs—outwards. In this central position, then, the pressure reached its least value, and the resultant pressure of the surrounding liquid caused the discs to move towards one another.

I must not trespass on your time by discussing the other experiments, but they are most beautful illustrations of the theory of the motion of liquids and gases.

If there were any liquid or any substance by the vortex motions in which we could suppose magnetic effects to take place, then we should have a most complete analogy between these motions and the action of magnetic poles on one another.

In the case of gases, I apprehend that the cause is the same as in the case of liquids; that, in fact, the result has more to do with the actual motion of the gas than the change of density taking place in the gas itself, although both conditions, of course, are present.

THE WALDUMER ELECTRO-MAGNETIC BRAKE.

The Chicago *Railway Review* of Aug. 5, 1882, says:—" We attended on the 29th ult. an exhibition of this brake in practical operation. Among the numerous appliances adopted and in operation since the invention of the locomotive itself probably none have contributed more to the general efficiency of railway service than the continuous brake. By its use the engineer obtains perfect control of his train, and, owing to his ability to make short stops, is enabled to maintain high speed for a longer distance between stations, ensuring thereby better time. . . . . The introduction of the automatic feature in continuous brakes, by means of which, in the event of a separation of the train, the separated portion is quickly stopped, has added much to the security of life and property. Until recently all practical forms of continuous brakes have been dependent on air for their actuating force, some utilising internal pressure, others external, and known respectively as the 'compressed air,' and 'vacuum' systems. For a short time past a series of satisfactory exhibits of a new device known as the Waldumer Electro-Magnetic Brake have been had on the New York, Woolhaven and Rockaway Railroad at Rockaway Beach, Long Island, in which electricity is used as the actuating and controlling medium. . . . The system consists of a dynamo-electric generator, coupled with and driven by a small rotary engine of an improved pattern, both of which, on the same bed-plate, are mounted on the running board of the locomotive, and controlled by the ordinary throttle valve. The mains conducting the electric current extend from the dynamo throughout the length of the train, in parallel lines, the system of circuiting being that known as the 'multiple-arc,' by which the interruption of current on one car affects no other car of the train. They consist of non-insulated copper wire, and are divided into car lengths, and fastened under the bodies. These separate lengths have as terminals flexible conductors of copper wire cable surrounded by rubber tubing, imparting to the whole much the same appearance, though in decreased dimensions, as the flexible terminals in the air-brake systems. For electric connectors or couplings, a dovetail tongue and groove device is used, each member of the coupling having both tongue and groove, thereby ensuring perfect connection under all circumstances. A flat spring, through which the tongue projects, maintains perfect contact, takes up all wear, and binds all parts sufficiently to prevent separation from any cause, except a strong direct pull resulting from the separation of the car from the rest of the train, in which event the uncoupling is automatic, the whole coupling being cheap, durable, and reliable. From the mains, branch wires extend to brass strips or springs in contact with two brass discs fixed upon, but insulated from, the axle and from each other. They serve to conduct the current to the brake itself, which consists of a three-flanged, spool-shaped electro-magnet, a part of and revolving with the axle. Its dimensions are 4in. by 15in., and it is wrapped with four layers of No. 8 wire, one of the spaces in a contrary direction to that of the other. This has the effect of concentrating the magnetic force where it is wanted, instead of directing it to the extremities of the axle. The electro-magnet has for an armature nine square wrought-iron bars, one inch by 16 inches in length, which are used as delivered from the mill without finish of any kind. These extend over the three poles of the electro-magnet, to whose cylindrical form they adjust themselves, and have their ends engaged in slots in the heads of the drum surrounding the whole. A false head, dust-proof, covers these ends, keeps the bars in place, and also serves to hold a circular spring, keeping them nominally out of contact with the magnet, and preventing unnecessary wear. A chair is fastened to and extends from the drum just described to a grooved wheel, which takes the place of the hand wheel in the hand brake. From the shaft of this wheel another chain extends to the ordinary brake lever. This device in no way interferes with the hand brake, which is indispensable in making up trains, &c. In order that the brake may be set with the minimum of initial motion, and at the same time obtaining the maximum

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leverage, a 'take up' in the form of a half excentric is made part of the wheel, and is grooved to receive the chain connecting with the lever, so that, instead of requiring three revolutions of the grooved wheel to take up the necessary motion on the shaft, it is done in a half turn. This is possible in braking, because much motion and very little power are required to bring the shoes to the wheels, and much power with scarcely any motion after that. The gross leverage is 104·4 to 1. To operate the brake it is only necessary for the engineer to open the throttle valve of the rotary engine to the degree required, the amount and strength of current depending directly upon the speed of the engine and dynamo. The amount of current is indicated upon an electric gauge. . . . . . As the magnet revolves with the axle, the bars, and, consequently, the drum, in the heads of which their ends are engaged, revolve with it until the brake shoes are brought against the wheels, where they are held as powerfully as may be desired, though the whole system may be instantly released, or the pressure decreased, by closing the throttle valve. When the shoes are hard against the wheels, the motion of the drum ceases, and it is simply held in place, though the magnet continues to revolve. It is, in fact, a frictional appliance, in which the friction is applied and regulated by the electric current. It has also the advantage of contact between armature and magnet, an item of importance. In the exhibits at Rockaway Beach the train consisted of a 40-ton engine, a 20-ton tender, four empty box-freight cars of about 10 tons each, and a 20-ton passenger coach. The only brakes applied were those on the four empty freight cars, yet the entire train was under perfect control, stops at stations being made accurately at varying rates of speed up to 30 miles per hour. At the latter rate stops were made in twice the length of the train. When travelling at the same rate, the coupling pin of the last car was pulled and the brake automatically set, stopping the car within a distance of about 60ft." There is claimed for this brake its cheapness, simplicity, and durability; that its operation is in no way affected by the condition of the weather, that it is economical to operate, requires no air-tight fittings, can be applied to trains of any length, will do better work without sliding wheels, and possesses all the merits of continuous brakes. The inventor of the brake is Mr. A. L. Dawelius, and it is owned by the Waldemur Electro-Magnetic Brake Company, of Cincinnati, the European patents being in the hands of Dr. Paget Higgs.

ELECTRIC LIGHTING AND FIRE RISKS.

Mr. Musgrave Heaphy, C.E., of the Phœnix Fire Insurance Office, writes to *The Times* of Thursday, giving several simple rules by the following out of which he thinks occupiers and owners of house property will be able to materially reduce the risk of fire, where electric lights are in use. The rules are as follow:—"Rule 1. See that no naked wires are used. Try and arrange that they be covered with a material rendered as incombustible as possible. This you can very easily test for yourself. Rule 2. See that all wires are kept at least one inch apart from each other (if they are 'leads' two inches), and one inch from all metallic substances. Rule 3. See that no wire hangs loosely, and that they are in such a position as not to be liable to derangement or injury from external causes. Get them enclosed, if possible, in wood or slate beading having a continuous fillet to keep the wires separate. Rule 4. See that none of the fastenings of the wires are composed of metal. Rule 5. Have a 'cut out' for every room, and if possible for every light. A 'cut out' is a short piece of easy fusible metal—such as lead—inserted in the wire conveying the electricity to the light or lights. Rule 6. See that your wires—unless they have a waterproof covering —are kept free from wet." In concluding his letter, Mr. Heaphy says:—"This last rule is more important than it seems, for, paradoxical as it may appear to those not versed in the subject, water can easily bring about a fire through its property of conducting electricity, several cases of wood being charred having already arisen, and a fire in America has occured from this cause. The above rules apply to incandescent lighting only, as in every case of arc or semi-incandescent installations an inspection will probably be made by the fire office insuring the building. In order to prevent any unnecessary alarm in the mind of the public, I may state that all my experience so far has not caused me to alter in any way the opinion contained in my report, viz.:—'That where systematic and proper precautions are taken there is less danger from electric lighting than from gas; but that if carelessly or ignorantly arranged, or improperly worked, then serious fires may be apprehended.' Unfortunately the demand for competent men to lay the wires is already exceeding the supply. It is only fair to state that the care taken to prevent fires by one or two of the electrical companies deserves much praise. I regret having to withhold their names, as I do not wish the accusation brought against me of giving undue prominence to any of them."

ON A METHOD OF INVESTIGATING MAGNETIC SUSCEPTIBILITY.*

BY SIR WILLIAM THOMSON.

After referring to the experiments of Thalen on ellipsoids of iron and of Rowland on iron rings, Sir William Thomson described a method which he said had been adopted in some experiments on the magnetic susceptibility of iron and steel, performed in the Physical Laboratory of Glasgow University by Mr. R. Shida.

The method consists in taking a series of measurements of the normal force exerted by a thin cylindrical bar on a small magnetic needle placed near it, while the bar is being moved from a position a considerable distance above or below the needle to a position a considerable distance below or above it. When the deflections of the needle are laid out in a curve to the proper scale the area included between the coordinates and the curve gives the total amount of magnetism in the bar. The results of these experiments will, it is expected, be communicated to the Royal Society at an early date.

* Abstract of Paper read at British Association meeting, Southampton.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Sept. 27.		Business Done Week Ending Sept. 27. Highest.	Lowest.
Anglo-American	50½,	51⅛	51⅞	50⅛
Do. Preferred	82½,	83½	84	82¼
Do. Deferred	19,	20	21	19⅛
Brazil Submarine	11⅞,	12⅛	12 1-16	11¾
Cuba	9¾,	10¼	—	—
Do. Preference	16,	17	—	—
Direct Spanish	6¼,	6¾	—	—
Do. Preference	15½,	16⅛	—	—
Direct United States Cable	11½,	12	12	11 9-16
Eastern Telegraph	10¾,	11	11 1-16	10¾
Do. 6 per Cent. Preference	13,	13½	13	12¾
Do. 5 per Cent. Debentures, 1899	100,	105	—	—
Eastern Extension	11⅜,	11⅝	11 9-16	11⅜
German Union	9¾,	10¼	—	—
Globe Telegraph and Trust Company.	6⅝,	6⅞	6 13-16	6¾
Do. Preference	12⅝,	12⅞	12 13-16	12⅝
Great Northern	12½,	12¾	12¾	12⅝
Indo-European	29½,	30½	—	—
Mediterranean Extension	1¾,	2¼	2	2
Do. Preference	8,	9	—	—
Reuter's	12¾,	13¼	—	—
Submarine	255,	265	—	—
West India and Panama	1⅝,	1⅞	1 13-16	1 11-16
Do. 1st Preference	8½,	9	8¾	8 11-16
Western Brazilian	6¾,	7¼	6 15-16	6 13-16
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Companies.	Closing Prices Sept. 27.		Highest.	Lowest.
Consol. Telephone and Maintenance	1⅛,	1⅜	1⅜	1¼
Oriental	¾,	1	1	¾
United Telephone	10¼,	10¾	10⅝	10⅝

ELECTRIC LIGHT.

Companies.	Closing Prices Sept. 27.		Highest.	Lowest.
Maxim-Weston	⅝,	⅞	13-16	¾
Anglo-American Brush	12¼,	12¾	12⅝	11¾
Eastern Electric	2,	2½	2⅜	2¼

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

4607. **Improvements in Magneto-Electric Machines,** *H. F. Joel, Dalston.—21st October,* 1881. 6*d.*

This invention consists in structural improvements in magneto machines constructed on the Pacinotti principle. Fig. 1 shows a side elevation, and Fig. 2 gives details of the armature. There are four upright field electro-magnets, arranged in pairs, with the wire so coiled as to make the north and south poles of each pair in the centre of the magnets and opposite to one another. The armature is constructed in eight or more—preferably nine—distinct sections, of which the iron cores are made of small plates joined together,

4607 FIG 1

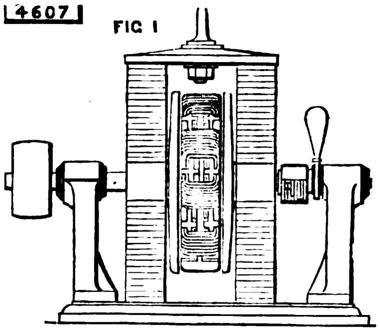
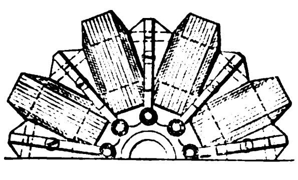


FIG 2



so as to alternately overlap, and when fitted they form two separate iron wheels of flat surface. Each of these sections is separately wound with insulated wire, and when fitted are attached to radial spokes with special iron cheeks. These cheeks bind the sections together and make a complete ring armature. The outer faces of the cheeks are grooved for better access of air. The commutator is constructed of separate pieces of metal of step shape, with their centres of narrow width, which fit into grooves cut in a ring of insulating material. Other improvements are also described and claimed.

5593. **Improvements in Dynamo-Electric Machines,** *L. S. Powell, Notting-hill, Middlesex.—21st December,* 1881.—*(A communication from J. M. A. Gérard-Lescuyer, Paris.)* 6*d.*

This dynamo machine is constructed with a movable inductor formed by a wheel of brass or gun-metal keyed on a shaft. Straight electro-magnets are arranged on the circumference of this wheel, so as to present alternate poles on

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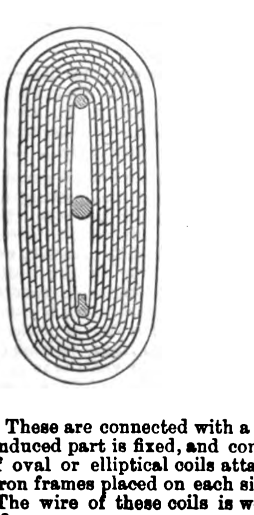
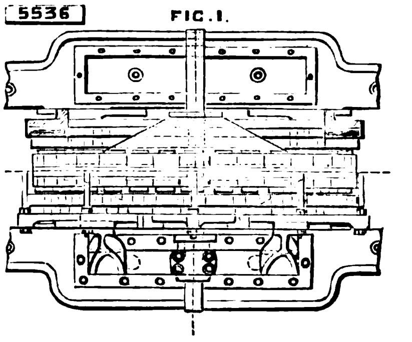


each side of it. These are connected with a commutator. The induced part is fixed, and consists of two series of oval or elliptical coils attached to two annular iron frames placed on each side of the inductor. The wire of these coils is wound as shown in the figure.

5536. **Dynamo-electric Machines,** *J. E. H. Gordon.—17th December,* 1881. 6*d.*

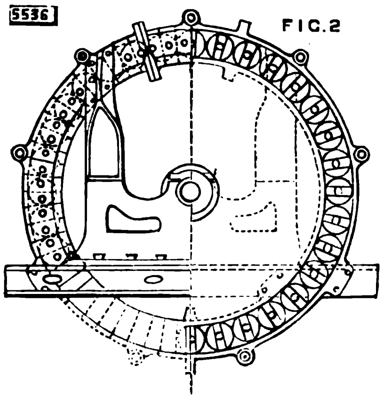
This refers to improvements upon the machine described in specification No. 78, 1881. In the former machine inductive action interfered with economical working. In it the number of armature and magnet coils was equal, in the new machine the armature coils are double in number

5536 FIG. 1.



as regards the magnet coils. The fixed coils may be made wedge-shaped to get more wire on the machine and economise space. Fig. 1 shows a plan, and Fig. 2 an elevation, of the machine, which has one wheel of magnets. The sole plate is 13ft. 4in. by 7in. The wheel is built of boiler plate, though steel may be used. There are thirty-two magnets in the wheel. Each magnet

5536 FIG. 2



consists of a cylindrical iron core of two bobbins of brass, &c., containing wire and two pole pieces. The core passes through a disc and wrought iron ring, and projects equally on either side. The bobbins are slipped on and fixed by the pole pieces. The number of fixed coils is sixty-four, fixed to each ring, so that the sixty-four poles facing the magnet wheel are acted on by the thirty-two magnet poles facing them.

260,111. **Commutator for Dynamo-Electric Machines,** *James J. and Thomas J. M'Tighe, Pittsburg, Pa.—Filed May 3rd,* 1882.

Claim.—(1) A commutator composed of a single cylinder of insulating material, having one or more integral collars perforated longitudinally with a circular series of holes, in combination with a series of metal rods or bars placed in said perforations and retained by the collar or collars, substantially as specified. (2) A commutator

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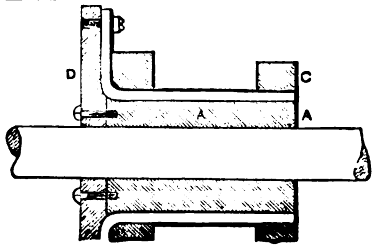
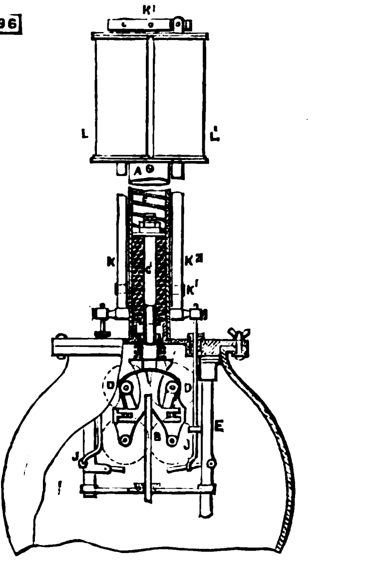


composed of a single cylinder of insulating material, A, having one or more integral collars, C, perforated longitudinally with a circular series of holes, in combination with a series of metal rods or bars, placed in said perforations, and having the extensions, a head, D, of insulating material, clamping the extensions against the cylinder A, or collar, C, and screws, substantially as described.

5396. **Improvements in Electric Lamps,** *C. F. Varley, Bexley Heath, Kent, and F. H. Varley, Mildmay Park, Middlesex.—9th December,* 1881. 6*d.*

One method by which the inventors construct their lamp is shown in the figure. The upper carbon B is held in hollow cylinder A, being fed forward by spiral spring C or weight C^1; D D are roller clutch contacts by which the current is conveyed to carbon B; E is a swing arm which carries the lower carbon, this latter being fixed. To regulate the arc regulators J are provided, attached as shown to rods K and K^2, which run through coils L and L^1. One of these coils is in the main, the other in a shunt circuit. Coil L is constructed so as to counteract the influence of

5396



the main circuit coil L^1 when the resistance of the arc has arrived at the proper limits for obtaining the best light; K and K^2 are jointed to the balance arm K^1, so that when a current flows through L^1 by the circuit being completed through the carbons, K is drawn upwards, forcing K^2 downwards until J J are forced into the teeth of D D, forcing them back, and with them the upper carbon B, and so establishing the arc. Other methods of constructing the lamp are also described. The inventors claim the roller contact, swing arm, balance rods, and the use of a cylinder and piston with air checks to regulate the carbon feed; also the use of bi-carbonate of soda for coating reflectors, &c.

260,541. **Dynamo-Electric Machine,** *J. A. I. Craig, Montreal, Quebec, Canada, assignor of two-thirds to E. R. Whitney and C. L. Bossé, both of same place.—Filed October* 26, 1881.

Brief.—The commutator brushes are formed of discs of wire-cloth arranged in groups, and the groups separated by washers, the whole clamped

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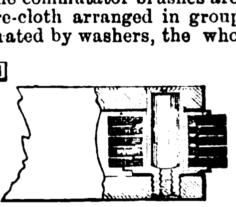

upon a sleeve, which serves as a journal bearing A hollow spindle upon which the brush rotates is perforated, and serves to distribute lubricating material to the bearing.

5431. **Improvements in Telephones,** *A. W. Rose, Hatton-garden, Middlesex.—12th December,* 1881. 6*d.*

This relates to telephone receivers in which sounds are received by disturbing the statical charge of a circuit. Instead of constructing the receiver with two diaphragms fixed in a case at a short distance from one another, the inventor employs a rigid disc divided into two parts which are separated by insulating material. One half of the disc is connected with the secondary wire of an induction coil, and the other half with earth or a return wire. Opposite this divided disc is a metal diaphragm secured at its edges and arranged at a short distance from the disc. The secondary current passes from line to one half of the disc, across to the diaphragm and back to the other half of the disc, and thence to earth. By this means two positive semi-vibrations of the diaphragm are obtained for each electric propulsion, and consequently better articulation.

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4641. TARGETS, *W. R. Lake, London.—(A communication from A. Bowin, Paris.)*—22*nd October*, 1881. 6d.

The target is made of small pieces, which, when hit, make an electric contact, and a signal is given indicating the part hit.

4947. ELECTRO-PLATING, *F. Wirth, Frankfort.*—11*th November.—(A communication from A. Classen, Aix-la-Chapelle.)* 4*d*.

Solutions of chlorides or sulphates of the metals to be deposited are transformed by a solution of neutral potassium oxalates into soluble potassium double salts. The solution is heated, and in it is dissolved an excess of ammonium oxalate. A small quantity of sodium carbonate is added. The article to be plated is connected to the pole of the battery.

4966. SIGNALLING APPARATUS FOR RAILWAYS, *W. R. Lake, London.*—12*th November*, 1881. *—(A communication from J. B. Johnson, Boston, U.S.)* 6d.

Mechanism connected with the rotating armatures of a magneto machine is actuated by the passing train.

5006. A NEW OR IMPROVED METHOD AND APPARATUS FOR REGULATING THE PRODUCTION OF ELECTRICITY BY DYNAMO-ELECTRIC MACHINES, *F. Wright, London, and F. A. Ormiston, Twickenham.*—15*th November*, 1881.—*(Not proceeded with.)* 2d.

This relates to the introduction of varying resistances into the circuit of the field magnets of the dynamo, and thereby regulating the current.

5026. IMPROVEMENTS IN TELEPHONE RECEIVERS, *F. H. W. Higgins, Stoke Newington.*—16*th November*, 1881.—*(Not proceeded with.)* 2d.

This relates to the use of a solenoid attached to the diaphragm, a magnet fixed to the handle of the telephone projecting into but not touching the solenoid.

5140. IMPROVEMENTS IN TELEPHONIC AND TELEGRAPHIC SIGNALLING APPARATUS, *A. C. Brown and H. A. C. Saunders, London.*—24*th November*, 1881. 6*d*.

This relates to improvements whereby a series of stations are connected by one line wire, and any station can communicate with any other station on the same line, the wire being unoccupied, without the intermediate stations being able to interrupt. This is accomplished by the provision at each station of an instrument with a graduated series of resistances which the operator can insert in the line circuit; each instrument is provided with an electro-magnet, with armature held back by springs differently adjusted for appreciating the resistance in the line circuit. This controls the connections both of the resistances and the receiver and transmitter, preventing their being placed in connection with line except the line resistance has been set to a pre-arranged quantity. Each instrument is also provided with blocking parts, which render the variation of the resistance inoperative in the instrument in which it is produced. The inventors claim the above arrangements, also a method of connecting two telephones by an induction coil, and a switch arrangement for shunting the receiving telephone and secondary cells of the induction coil out of the line circuit.

5234. FIRE ALARMS, &c., *W. T. Braham, Manchester.*—30*th November*, 1881. 6*d*.

This consists of an apparatus that shall on the occurrence of a fire in its immediate vicinity do any or all of the following acts, that is to say, it may sound an alarum or alarums, transmit electric currents or telegraphic signals to any place or places desired, or turn on a supply of water through a series of perforated pipes for the purpose of extinguishing the flames.

5407. AN IMPROVED MANUFACTURE OF COMPOUNDS FOR ELECTRIC INSULATION, *W. Abbott, Limehouse, Middlesex.*—10*th December*, 1881.—*(Not proceeded with.)* 2*d*.

This relates to improvements on Field and Talling's patent (No. 1938, of 1875) for an insulating compound of ozokerit and india rubber, which enabled said compound to be thoroughly vulcanised and hardened.

5418. IMPROVEMENTS IN THE ARRANGEMENT OF ELECTRICAL APPARATUS ON RAILWAY TRAINS, *J. E. Liardet, Brockley, and T. Donnithorne, London.*—10*th December*, 1881. 6d.

This relates to a combination of dynamo machines placed in a portion of the train, and driven by gearing from the axle of a carriage; these supply current to secondary batteries, which in turn feed electric lamps, or supply current for other purposes.

5430. IMPROVEMENTS IN TELEPHONES, *A. W. Rose, Hatton-garden, Middlesex.*—12*th December*, 1881. 4*d*.

This invention consists in the employment of a compound diaphragm, the central portion of which is made of thin material and the outer portion of a comparatively thick material.

5432. IMPROVEMENTS IN TELEPHONES, *A. W. Rose, Hatton-garden, Middlesex.*—12*th December*, 1881.—4*d*.

This relates to a microphonic transmitter, and consists in the combination with the compound microphone of a thin vibrating diaphragm of mica or other material in substitution of the ordinary rigid wooden board. The diaphragm may be in connection with all the carbon buttons, or only the centre one; it is attached to the mouthpiece by its edges.

5445. IMPROVEMENTS IN GALVANIC BATTERIES, AND IN THEIR APPLICATION TO ELECTRIC LAMPS, *O. C. D. Ross, Camberwell, Surrey.*—13*th December*, 1881. 4d.

The inventor employs a carbon zinc battery, and uses small lumps of amalgamated zinc in the zinc cell, by which means he exposes a larger surface for chemical action. In the carbon cell he employs hydrochloric acid, either pure or diluted with about one-fifth of its volume of water, but its action must be strengthened by the addition of about 5 to 10 per cent. of some powerful oxidising agent, such as nitric or nitrous acid. In the zinc cell he uses sulphurous or hydrochloric acid diluted with from 8 to 20 parts of water. The inventor claims the above battery, and also the arrangement of a secondary battery between the above battery and electric lamps.

5452. IMPROVEMENTS IN APPARATUS TO BE USED IN CONNECTION WITH ELECTRICAL BATTERIES FOR CHARGING THE SAME, &c., *W. R. Lake, London.*—13*th December*, 1881. *—(A communication from J. F. Aymonnet, Paris.)* 8*d*.

This relates to apparatus for charging and discharging batteries, and for maintaining the liquid in them at a constant height automatically; also to the provision of a disinfecter for batteries giving off bad gases.

5468. IMPROVEMENTS IN TELEGRAPH OR TELEPHONE CONDUCTORS, *J. Imray, London.*—14*th December*, 1881.—*(A communication from J. M. Stearns, jun., Brooklyn, U.S.)* 4*d*.

To overcome induction effects the inventor folds up a thin sheet of copper along with the insulated conductors in a zig-zag manner, so that portions of this metal are everywhere interposed between each conductor and those next to it. This metal sheet is at numerous points connected to earth.

5481. IMPROVEMENTS IN SECONDARY BATTERIES, *D. G. FitzGerald, Brixton, Surrey.*—14*th December*, 1881. 4*d*.

The inventor employs carbon in the form of fragments in direct contact with each other at one or more points, whilst the interstices between them are filled with lead in a state of division or with an oxide of lead, such as red lead, or with an insoluble salt of lead such as the sulphate. The carbon fragments may be first coated with lead by immersing them in a solution of a salt of that metal, such as the acetate, and subsequently reducing the metal by heating without access of air, or electrolysis. In the construction of a cell the carbon fragments are divided into two portions, each of which is in contact with a plate of carbon to which a terminal is attached. The two portions are prevented from coming into contact by the use of a diaphragm of felt or other material. The inventor also claims the use of the mixture of carbon fragments with lead in a state of fine division, or an insoluble compound of lead in conjunction with a tube or vessel of carbon or lead, perforated with apertures which are closed with or covered by a porous material.

5185. IMPROVEMENTS IN ELECTRIC LAMPS, *E. G. Brewer, London.*—28*th November*, 1881.—*(A communication from A. G. Waterhouse, New York.)* 1s.

This relates to arc lamps in which the carbons are controlled by a clutch or wheel work governed by an electro-magnet, and to a novel device for shunting the current past the lamp. There are twenty-six claims.

5470. IMPROVEMENTS IN GALVANIC BATTERIES, *C. Mauris, Westbourne Park, Middlesex.*—14*th December*, 1881.—*(A communication from A. Thomas, Nantes, France.)*—*(Not proceeded with.)*. 2d.

The elements are in the shape of semicircular discs perforated with numerous holes, and are fixed on an axis from which they are insulated. The axis can be revolved so that only a portion of the plates are submerged in the exciting liquid, or they can be withdrawn altogether.

5494. IMPROVEMENTS IN SECONDARY VOLTAIC CELLS, *J. W. Swan, Newcastle-on-Tyne.*—15*th December*, 1881. 2*d*.

This relates to forming the plates for secondary batteries. The inventor takes plates of lead, corrugated as described in his previous patent, No. 2272, dated 24th May, 1881, and exposes them to the combined action of ascetic acid, carbonic acid, and atmospheric air, which results in the formation of carbonate of lead on the plates. After this action has taken place to a sufficient depth, a portion of the plates being left unacted upon, he subjects them to the action of electrolytic hydrogen by making them the cathode of an electric generator. The plates are then made up into cells as usual in Planté's cells.

5499. IMPROVEMENTS IN MEASURING AND RECORDING ELECTRIC CURRENTS, AND IN THE APPARATUS EMPLOYED THEREIN, *J. W. Swan, Newcastle-on-Tyne.* — 16*th December*, 1881. 4*d*.

This relates to improvements in an electric meter described in patent No. 5,004, taken out by the present inventor on the 1st December, 1880. The first improvement consists in avoiding the necessity for branch wires from each lamp and the meter, by taking the main conductor, or a shunt from it, round the several electro-magnets which determine the engagement of the pawls with the counting apparatus, and adjusting the springs which counteract the pull of these electro-magnets, so that when the current for the supply of one lamp is passing through the main wire or shunt, only one magnet armature will be attracted, and so that the number of magnet armatures rendered operative by any current shall correspond with the number of lamps lighted. Another improvement consists in arranging the motor which actuates the counting mechanism so as to commence action simultaneously with the coming into action of any of the electro-magnets. This is accomplished by the use of a solenoid in the circuit of the main wire or in a shunt from it, so arranged that the position of its core will vary with the strength of the current passing, and so connect the motor and counting mechanism as to cause the rate of counting to vary as above indicated. It also relates to a means of combining an automatically variable resistance connected in series with an electrolytic cell, and in multiple arc with the lamps, arranged so as to give a reciprocating motion to a balance beam connected with the counting mechanism.

5600. IMPROVEMENT IN ELECTRIC LIGHTING APPARATUS FOR RAILWAY TRAINS AND OTHER PURPOSES, *S. Pitt, Sutton.*—21*st December*, 1881.—*(A communication from E. F. Starr, Philadelphia.)*. 6d.

This relates to a mode of generating electricity for lighting trains and storing a portion of the electrical energy for use when the train is at a standstill. The inventor places his dynamo under the tender of the engine, where it is driven from an axle as long as the train goes forward, but not when the engine is reversed and travels backwards. The dynamo is connected with an electric lamp on the funnel of the engine, and one at the rear of the train, and also with a storage battery. When the train is in motion the current lights the two lamps, whilst a portion goes to the battery, and does work there which can be afterwards utilised when the train is at a standstill. An interrupter placed in the circuit of the tail light causes it to flash at regular intervals, thus denoting the rear of the train, and also, as the interrupter is driven from an axle of the train, the speed at which said train is going.

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SLIP

Persia and the East Indies.—The cable between Fao and Bushire is interrupted.

Worcester.—The Corporation of this city have resolved to supply their own electricity.

Electric Light in Paris.—The Bon Marché in Paris is to be lighted by the Edison system.

China.—The cables between Shanghai and Amoy, and between Amoy and Hong Kong are interrupted.

Egypt.—Telegrams for all parts of Egypt are now accepted, and the restrictions as regards messages in cypher have been removed.

Brazilian Submarine Telegraph Company.—The telegraph receipts of this company for the week ended Sept. 29 amounted to £3,588.

Direct Spanish Telegraph Company.—This company have removed their offices from 106, Cannon-street, E.C., to 1, Leadenhall-street, E.C.

The Telegraph in China.—News from Shanghai under date August 29 says that telegraphic communication is to be established between Tients'n and Chefoo.

Electric Light at Cambuslang (Scotland).—It is stated that the streets of this small Scotch town are to be lighted by electric lights. The system is not mentioned.

New Company in Canada.—The Dominion Iron Company has applied for letters of incorporation, and asks powers for the company to construct and work telegraph and telephone lines.

The Crystal Palace Exhibition.—The amount at present subscribed by the gas companies to defray the expenses of the special committee of the Gas Institute in connection with this forthcoming exhibition is £4,962.

Cairo.—The Eastern Telegraph Company notifies the restoration of its direct wires to Cairo and the re-opening of the company's station in that city. Telegrams written in code language are again accepted for all places in Egypt.

The Telephone at Sunderland.—The River Wear Commissioners have given permission to the Northern District Telephone Company to extend their system of communication to the docks. Ship owners will, doubtless, appreciate this.

The Telephone in Cairo.—The directors of the Oriental Telephone Company have received a telegram from their agent in Egypt, stating that the Cairo Telephone Exchange is re-opened, and that that in Alexandria will re-open in a few days.

Western and Brazilian Telegraph Company.—The traffic receipts of this company for the week ending 29th September, 1882, were £2,360, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

Electric Light in London.—Messrs. B. Verity and Sons' establishment in King-street, Covent-garden, W.C., is now lighted by the Edison system, sixty lamps being in use. Messrs. Verity are large makers of gas and electric light fittings, electroliers, &c.

The Electric Exhibition at Munich.—A telegram from Munich dated the 1st inst. states that a fire broke out on that day in the Electric Exhibition, but the flames were immediately observed and extinguished. It does not say what was the cause of the fire.

A Telephone Line without Insulators.—The Evansville (Ind.) Telephone Exchange Company work 400 miles of line without insulators of any kind, the wires being simply attached to the poles. It is even stated that this line has been found to work better than one on insulators.

Electric Light in Cairo.—According to the da ly press, the Ghezireh Gardens at Cairo were illuminated by the Brush system on Monday last, on the occasion of a garden *fête* given in honour of Sir G. Wolseley, the Duke of Connaught, and other officers of the British army, by the Khedive.

West Indies.—The cable between Martinique and St. Lucia is interrupted. That between St. Thomas and St. Kitts which has been interrupted is now repaired. There is still no telegraphic communication with the Islands of St. Lucia, St. Vincent, and Barbadoes, as notified in our last issue.

Crookes's Lamp.—On the occasion of a *conversazione* held at the London Hospital, Whitechapel, on Tuesday night, parts of the hospital were lighted by means of forty of Professor Crookes's incandescent lamps of twenty-five candle-power each, the current being derived from a Gülcher dynamo machine.

The Telephone in America.—According to a report presented to the recent telephone convention held in Boston, there are about 60,000 to 70,000 subscribers in the United States. In New York there are 2,873, and the smallest number in any one place is 10. There is a steady and continued growth all over the country.

Search Lights for the Navy.—The British Electric Light Company, of Heddon-street, Regent-street, have received an order from the Admiralty to supply the following search light apparatus for war vessels:—Eight large 40,000 candle-power Gramme machines, eight projectors, and eight hand lamps, as used in the late war.

Fatal Accident.—The *Standard's* New York correspondent, telegraphing on Wednesday last, says:—"A workman who was repairing a lofty Brush light here received the electric current which was supplying forty lights. It passed through the man, who fell dead, the body dangling among the telegraph wires below. The hands were seared, and the face bore the expression of intense agony."

Lightning Conductors at Edinburgh.—At a recent meeting of the Edinburgh Town Council, authority was given to the city superintendent to obtain apparatus and employ professional assistance in inspecting lightning-conductors, in accordance with a request issued from the Home Office. We congratulate the Town Council of Edinburgh on the wisdom shown in so quickly following up the advice of the Home Office.

Electric Lighting in Berlin.—We take a few more details of the lighting of the Leipziger Strasse, in Berlin, by Messrs. Siemens and Halske, from a German paper. The lights extend from the Potsdam Platz to the Friedrichstrasse, and are 36 in number, being Siemens differential lamps. They are divided into three circuits of 12 each. The dynamo-machines—Hefner-Alteneck system—are driven by three gas engines. The cables are laid in leaden pipes.

Telegraphic Conference at Barbadoes.—The refusal of the Legislative Assembly to sanction the proposals of the Telegraphic Conference is very variously viewed by different sections of the community. By some it is urged that the outlay those proposals would involve would benefit only the mercantile community, while the latter insist that facilities for communication afforded to them must, through developing trade, materially aid all other classes.—*Colonies and India.*

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The Suez Canal.—*The Times*' correspondent at Constantinople telegraphs that the Suez Canal directors have ratified a convention with the Eastern Telegraph Company for a wire across the Canal Company's neutral zone, to connect the Red Sea and Mediterranean cables. M. de Lesseps, it may be remembered, refused such permission last August on the ground that the wire would have been utilised by the English for military purposes, which objection no longer exists.

A Little Foggy.—The little town of Petersfield, in Hampshire, has been debating as to whether or not the electric light should grace its streets. A provincial contemporary reports that its authorities have been recommended by a good authority to adopt the Swan lamp, but then makes the rather comical statement that this authority "considered that two wires giving a light of 16 candle-power would be sufficient." Our provincial contemporary has something to learn yet, evidently.

Electric Light in Theatres.—The theatre at Breunn, in Moravia, Austria, is entirely lighted by the Edison system, 800 to 900 lamps being in use. It is intended, we believe, to establish a large central station at Breunn from which to supply electricity for lighting and other purposes on the Edison system. Breunn is the centre of a large woollen manufacturing country, and already we hear that several factories are about to adopt the Edison system. Mr. Jehl is in charge of the work.

Legal Protection for Cables.—With reference to the forthcoming International Conference to be held in Paris on the 16th inst., to discuss the question of a convention providing for the protection of cables, the Berlin correspondent of the *Standard* says:—"Practical German telegraphists doubt the success of the Conference, partly because England will, it is believed, probably oppose any neutralisation scheme, but chiefly on account of the natural obstacles to its realisation, which appear almost insurmountable."

Becquerel.—A statue has been erected in honour of the French electrician, Antoine César Becquerel, and was unveiled at Chatillon-sur-Loing, on the 24th September. The money was raised by public subscription. Becquerel was the inventor of the first two-liquid battery, which is now known as the Callaud cell. The statue represents the great physicist in the attitude of a professor in the act of explaining the working of an electro-chemical apparatus. M. Cochery, Minister of Posts and Telegraphs, unveiled the statue.

Electric Light at Swansea.—There are five Brush lamps now in use at the East Dock, Swansea. They are supplied with current from a Brush dynamo about 400 yards distant from the lamps, the wires being laid underground. The dynamo is driven by an eight horse-power horizontal engine, specially constructed for the work by Messrs. Dyne, Steel, and Son, engineers, of Swansea, and fitted with a very sensitive governor. The work of erecting the lights, &c., has been carried out for the Harbour Trustees by their own officials.

Mr. Spottiswoode.—We regret to learn that the President of the Royal Society, Mr. Spottiswoode, has met with an accident and broken his left arm. The accident occurred at his residence near Sevenoaks. We are, however, glad to hear that he is doing well, and hopes soon to be again about at his work. With the daily increased importance of electricity, we should much regret any serious check in his inquiries into the principles which govern electric action, for the sake of which inquiry he has fitted up a very extensive set of apparatus.—*Daily News.*

The Lever Arc Lamp.—An exhibition of his lamp was recently given by Mr. Charles Lever, of Bowdon, Cheshire, at the works of Mr. A. W. Richardson, engineer, in Manchester. Four lamps, of an estimated power of 2,000 candles each, were supplied with current from a Bürgin dynamo driven by one of Marshall and Co.'s 4 horse-power vertical engines. The light given is said to have been very steady. On this point, however, our readers will probably be able to satisfy themselves before long, as it is the intention of Mr. Lever to exhibit his lamps at the forthcoming Crystal Palace Exhibition.

Associated Chambers of Commerce.—At the autumnal meeting of these chambers held during the week at Plymouth, resolutions were passed as follow:—In favour of negotiations being entered into by Government with foreign countries for the cheapening and facilitating of telegraphic communication; in favour of a Bill to amend the present patent laws; in favour of legalising the standard wire and metal gauge approved by the Executive Council of the Chambers; and, finally, expressing satisfaction at the participation of Government in the International Conference for the protection of cables about to meet in Paris.

Electric Light at Guy's Hospital.—On the occasion of the opening *soirée* at Guy's Hospital, on the 2nd instant, the wards, &c., used as reception rooms and for refreshments, together with staircases, courtyard, and passages, were lighted by fourteen Siemens differential lamps, while the anatomical museum was lighted by seventy-one Swan lamps, and the electrifying room by ten. The necessary current was derived from a Siemens W_1 D_7 machine, arranged in three circuits, of which one was for the Swan lamps and two for the arc lamps. The machine was mounted on a tumbril carriage, and was driven by a Marshall portable engine. The lights were supplied and erected by Messrs. Siemens Bros.

The Maxim and Weston Lights in Liverpool.—The Maxim-Weston Company have a large station in Peter's-lane, Liverpool, from which they are at present lighting the Prince of Wales' and Court Theatres, as well as Messrs. Hyams' premises in Lime-street. The station has about 6,000ft. of floor area, with engine-power sufficient, it is said, to light an area of half a mile. The dynamo machines in the station at present are capable of supplying current to lamps of the aggregate value of 500,000 candles. Another station is being got ready in London-road, from which the company will supply current for the lights about to be put into the Alexandra Theatre. We believe that these stations and the present company's contracts are to be handed over to the Lancashire Maxim-Weston Company.

The Telephone at Newcastle.—At a *conversazione* given in the Town Hall, Newcastle-on-Tyne, last week, in honour of the members of the Sanitary Congress then being held, a telephone line between the town hall and the post office was fitted up for the benefit of the visitors. Many availed themselves of the opportunity of testing the articulation of the instruments, and were agreeably surprised to find that they could recognise the voice of a friend with ease. This popularising of the telephone is a decidedly wise policy on the part of the companies, as there are many people who would adopt it at once, did they but thoroughly understand its powers and the saving in time and labour that can be effected by its means. We are rather surprised that large contractors do not make more use of it than would seem to be the case.

Accidents from Lightning.—Several more accidents from lightning have come to our notice, as having occurred during the severe thunderstorms which passed over the Midlands and north of England on Wednesday and Thurs-

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day week. Thus at Craghead, in the county of Durham, two boys, who were standing outside the door of their parents' house, were struck by lightning. One of the lads was killed, and the other sustained severe injuries. The mother, who was sitting inside, was also struck, and instantaneously killed. The needles with which she was knitting were twisted into the shape of a cork-screw. Near Nuneaton, in Warwickshire, where the storm was exceptionally severe, the guard of a goods train on the Midland Railway was struck twice by the electric current while he was riding in his van. It is stated that his neck was much blistered and swollen, though he did not appear to be otherwise injured.

A Massive Safe Deposit Vault.—The safe deposit vault for the Nassau Bank, corner of Beekman and Nassau-streets, New York, is said to be the largest steel vault ever constructed. It is made of welded chrome steel, iron, and Franklinite, and is, to all appearances, thoroughly fire and burglar proof. Entrance to the vault is effected through the bank proper. A staircase of marble and iron leads down into a well lighted and ventilated basement, about 12ft. high. The floor is paved with tile mosaics and marble. The vault, which is 35ft. long, 22ft. wide, and 9ft. high, is built clear of the walls of the building, and rests upon a thick foundation of concrete and granite. There are two massive iron doors at each end of the vault, and the outer ones are the largest single doors ever made for this purpose. Outside of the doors are electric burglar alarm doors, which cannot be tampered with without sounding a loud alarm. The vault is lighted by the electric light.

The Telephone at Nottingham.—During the Social Science Congress recently held in Nottingham, the National Telephone Company exhibited various kinds of telephones, as well as other electrical apparatus in University College. A portion of the exhibition consisted of views of the laying of the 1865 Atlantic cable which had been kindly lent for the occasion by Mr. L. J. Crossley, of Halifax. Amongst the telephones exhibited were the Blake, Crossley, and Moseley. The construction of these was fully explained by Mr. Fry, of the National Telephone Company. This gentleman also showed a telephone of Japanese make, and assured his audience that the progress made in Japan in electrical matters was quite as rapid as in England. Mr. Fry having been occupied for some time in Japan as a teacher, we conclude that his opinion may be accepted. Professor Hughes's induction balance and Edison's phonograph were also exhibited and described. A number of telephones were connected up to a wire leading to Messrs. Morley and Heanor's premises, so that those in the college were enabled to listen to the playing of a band composed of this firm's *employés*.

Electric Lighting and Gas in America.—In conversation with an eminent electrician, prominently connected with one of the leading electric light companies, the conclusions arrived at in previous articles on the effect of electric lighting on the gas interest and allied industries, says the *Engineering and Mining Journal*, were fully confirmed. Much significance has been attached to the fact that in this city a number of our most prominent thoroughfares have been illuminated by the electric light, and great damage to the interest of the gas companies has been predicted. Now, curiously, the very reverse has taken place. It is a fact that for every street lamp there are many times as many jets burning in private dwellings and stores along the line. The occupants coming from the strongly illuminated street have a desire for much more light than they formerly considered sufficient for their purposes, and the result is that the consumption of gas in houses along thoroughfares lighted by gas is now not only so much larger as to compensate for the loss on the street, but very much greater. Whatever future progress incandescent electric lighting may bring to change the relations between the two rivals for lighting our dwellings, there is no doubt that until now gas still holds sway.

Electric Lighting at the Royal Albert Dock.—As may be remembered, four stations have been erected in this dock by Messrs. Siemens, each containing a 20 h.-p. engine, supplied by Messrs. Marshall and Co., and a number of electrical machines. Some of these work the powerful arc lights suspended from tall latticed iron posts, and others, giving alternate currents, are connected with two main leading wires running along all the sheds on the north side of the dock. At each shed a commutator is provided, so that the current can be turned into the shed or the shed may be cut out. Specially constructed suspenders are suitably distributed over the interior, the front, and the back of the shed, to which the lanterns containing the electric lamps can be attached. Provision is also made for connecting ships lying alongside the quay by means of movable leading wires to the circuit, so that electric lights can be placed in the hatchways and below, for facilitating loading and unloading during night time. As this mode of working has given universal satisfaction on the north side of the docks, Messrs. Siemens have now received a further order from the dock company to fit up the sheds on the south side in a similar manner, and the work is being pushed on with all speed.

A New Steamer.—The new iron steamer "Albatross," lately launched at Wilmington, Del, for the use of the United States Fish Commission, says the *Scientific American*, will be ready for sea about December 1. Her dimensions are, length 200ft., beam 27·6ft., depth 16·9ft. She will be provided with two large laboratories, one on the upper deck amidships and the other immediately under this. In these laboratories all the microscopic work will be carried out and preparations made. One novel feature of this vessel for the pursuit of fish will be the use made of the electric light. The two methods employed will be the Brush for surface illumination, and the Edison for lighting up the depths of the sea. Between the Australian fisherman who spears his fish from his canoe, in the bottom of which burns some resinous wood, and a large vessel, illuminating the sea at great depths with the Edison incandescent light, there is all the wide difference between the barbarism of pre-historic time and the civilisation of the present. Her crew will consist of sixty-five men detailed from the Navy. Her chief officer is Lieut.-Commander Z. Tanner. She will carry a lieutenant, surgeon, and ensign officer, and two or three ensigns. Her first extended trip will be to England, to carry to the London Fisheries Exhibition the exhibits of the United States Fish Commission.

Secondary Batteries.—M. de Kabath writes to a recent issue of our contemporary, *L'Electricien*, describing experiments made in his laboratory with a view to the use of salts of lead in the manufacture of secondary batteries. He says:—We take neutral acetate of lead (sugar of lead), dissolve it in distilled water, 8 parts to 100 of acetate. As soon as it is dissolved we filter it. Then a plate of zinc is prepared of the dimensions that it is required to give to the accumulator. One side of this plate is covered with an insulating material composed of two parts of Japan varnish, one part resin, and one part lampblack. When the plate has been thus prepared it is placed in the solution at an angle of 30deg., and by chemical action, as soon as the plate has been plunged in the solution, the zinc is dissolved, and the lead contained in the solution replaces the zinc, thus pro-

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ducing a very pure mass of spongy lead. This latter is separated from the insulating material and placed between two perforated plates such as are employed in the construction of my accumulators. (These accumulators were illustrated in *The Electrician*, Vol. IX., page 61.) A layer of spongy lead and a perforated plate are superimposed, and these, when compressed, form electrodes ready for use. If, in place of the lead plate, bands or wires be used, a stronger band of lead must be soldered round the plate in order to render it compact. This element forms after from two to six hours charging, according to the thickness of the lead. In laboratory experiments it has given us very good results, only the spongy lead chemically obtained is destroyed very quickly. Exposed to the air, the whole of it crumbles to powder, and it is, in consequence, only of use for experiments, or in certain cases where the quick formation of an accumulator is a necessity.

Display of Aurora.—The *Daily Telegraph* of Tuesday last says:—"A fine, and in some respects remarkable, display of the Aurora Borealis was visible last night. Between half-past six and a quarter to seven, or about an hour after sunset, an arc of greyish white light was formed over the northern horizon, from the centre of which a series of bright ribbon-like streamers darted southwards, converging towards the zenith—the point straight overhead. Both the arc and the streamers varied considerably after the first ten minutes, nearly disappearing and then bursting forth again. More remarkable than the arc and the rays darting across the sky was a series of electric clouds, formed from ten to twenty degrees south of the celestial equator, and stretching across the heavens from east to west. That they were not vapour clouds was evident from these facts: 1st. They were self-luminous; as simple clouds they would have been invisible. 2nd. They vanished and re-appeared with the aurora, although always at a short interval after it. 3rd. They were too symmetrical in form and arrangement to be mere condensations of vapour. Each cloud was of a greyish or opal colour, and egg-shaped, the longer axis turned east and west; between them was a dark interval of about the length of the cloud, while the brightest and most permanent of the series were those at the eastern and western extremities. These clouds remained in sight for, probably, 10 to 15 minutes after the aurora had sunk to a mere effulgence over the northern horizon scarcely sufficient to attract attention. During a good part of yesterday the transmission of messages on the telegraph lines was interfered with by earth currents. Curiously enough, those lines appear to have been most affected which ran north and south, while east and west wires suffered little interruption." A correspondent of our own, writing from Belfast, describes a magnificent aurora seen there on Monday night. From other reports it appears that it was visible all over the British isles.

Electric Light at Hull.—On Thursday, the 28th September, the electric lighting of some of the streets of the old town of Hull was officially inspected by the Mayor of Hull and the Lighting Committee. The party assembled in the Town Hall at 7 p.m., and witnessed the starting of the lights in the various rooms and passages. Six arc lights, of about 1,000 candle-power each, supplied from an SD_8 machine, and about 100 Swan incandescent lights of 16 candle-power each, worked by two SD_2 machines, are employed for lighting up the building. Later on the lights in the streets were started, comprising four 3,000 candle-power lights, each worked by a D_7 machine, and 22 300 candle-power lights, worked by a W_1D_7 machine, in two circuits. The four large lights are suspended from William's tubular poles, about 50 feet above the roadway, and are enclosed in lanterns similar to those in use at the Royal Albert Dock. They are placed, one on the pier, the second on the Market-place, the third behind Trinity Church, and the fourth in Whitefriars-gate, near the bridge over the docks. The smaller lights are on lamp posts, exactly similar to those used last year in the City of London, and are distributed over the principal thoroughfares at about 100 yards distance from each other. The station is situated in the yard of Messrs. King and Co., South Church Side, and contains two 12 horse-power compound semi-portable engines, supplied by Messrs. Wallis and Stevens, of Basingstoke, each of which is capable of working the street lights alone. Suitable arrangements are also provided for measuring the currents, and for interchanging the machines. The Town Hall is about 1,000 yards distant from the station, and the two circuits of the smaller lights measure 1,930 and 1,700 yards respectively. The lighting was witnessed by a large crowd of people, who expressed themselves as very well satisfied with the result, and it will be continued for the next 12 months. The contract has been carried out by Messrs. Siemens Brothers and Co., the work being done under the superintendence of Mr. F. W. W. Melhuish.

Telephonic Vibrations.—In a recent communication to the French Academy of Sciences M. Salet gave some account of experiments which he had carried out to ascertain the amplitude of the vibrations of the diaphragm of a telephone receiver in action. He fixed on the iron diaphragm of a Bell telephone a small glass disc weighing 0·45 gramme, and in front of this was supported a second, furnishing with it Newton's rings. The arrangement resembles that devised by M. Fizeau for studying dilation. When the telephone was spoken to at a distance of about six yards, or when the telephonic current from a good transmitter (Bottcher's for instance) was sent into it, the rings were observed to lose their distinctness, and disappeared if the voice were a little forced. They vibrated, indeed, synchronously with the diaphragm, and nothing was simpler than to calculate, from the amplitude of their oscillations, that of the vibrations of the membrane. It is certain, however, that the surcharge of the diaphragm with the discs must lessen the movements slightly; thus the results obtained erred probably by defect rather than by excess. To estimate the displacement of the rings, M. Salet arranged before the telephone receiver, which was caused to emit a continuous sound, a turning disc pierced with slits, like that of a phenakistiscope. It was found that, with a certain velocity of rotation, the rings appeared with distinctness. On blowing then through the disc, so as to make it act as a siren, it was found that the sound produced was in unison with that transmitted by the telephone. If it were slightly lowered or raised, immediately the rings oscillated, at first slowly, then with such rapidity that they became invisible again. While they oscillated it was easy to estimate their displacement; in one experiment, the *la* of the diapason being emitted into the transmitter with a vowel *u* (*ou*), and with moderate intensity, the displacement was nearly equal to the distance of two consecutive rings, and the amplitude of vibrations of the receiving plate would thus be two to three ten-thousandths of a millimetre (a millimetre is ·039 of an inch). If currents of different intensities, but very weak, were sent into the telephone, neither of them caused displacement of the rings beyond half the distance separating them, it was possible by considering a point of the glass disc to infer from its brightness the intensity of the current. M. Salet is of opinion that this peculiar galvanometric process might be utilised in the telectroscopic receiver.

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ELECTRICITY.

ABSTRACT OF TWO LECTURES BY PROF. G. CHRYSTAL.

LECTURE II.

(CONCLUDED FROM PAGE 224.)

At the end of my last lecture I showed you that the kinetic energy of the electric current could be converted into the potential energy of chemical separation. Oxygen and hydrogen were given off at the two platinum plates of the voltameter, and the energy which a certain quantity of each had, by virtue of their separation, represented a certain fraction of the electro-kinetic energy of the current from Professor Tait's Gramme machine. In order to convince you that this potential energy of chemical separation had a real existence I caused it to be transformed into the energy of sound vibrations, and then it gave, as you may remember, an audible account of itself.

It is interesting to note that we have here another instance of the principle of reversion. We have seen, in fact, that the energy of chemical separation may be converted into electro-kinetic energy, and *vice versâ*. It is this action of the current that is made use of in the now extensive art of electro-metallurgy. Passing over all details on this subject, let us study for a moment a certain residual phenomenon that shows us that the voltameter is made the recipient of more energy than was accounted for by the energy of separation of the liberated gases.

[Here a current was sent through a voltameter, and the return current of polarisation demonstrated in the usual way.]

This result is expressed by saying that the voltameter has been polarised by the current. That is simply a cautious, scientific way of saying that it has been so far modified that you can distinguish the one end of it from the other. If I took two platinum plates exactly alike, say both cut from the same piece, and dipped them in dilute sulphuric acid, connecting them through a galvanometer, of course no current would be indicated. It would be astonishing, indeed, if any were indicated seeing that the current has direction associated with it. The result is otherwise when the plates have been made the gates of entrance and exit for a current passing in a particular direction through dilute sulphuric acid. Physicists have traced the source of the electromotive force of polarisation to the oxygen and hydrogen deposited in (or on) the platinum plates. The source of the energy of the current of polarisation, which is the main thing we are now concerned with, is therefore virtually the potential energy of the separated oxygen and hydrogen. This, however, is not the only kind of polarisation. In the great majority of liquids the passage of an electric current is accompanied by chemical decomposition, and in almost every such case there is a corresponding polarisation, depending partly on the nature of the immersed plates, and partly on the liquid.

ACCUMULATORS.

The electromotive force of the famous secondary batteries' or accumulators, as the fashion now is to call them, is simply an extreme form of polarisation. I will content myself with briefly describing the one which has recently acquired notoriety under the name of the Faure accumulator. It consists of two large plates of sheet lead, each of which is coated with minium or red lead, Pb_3O_4. They are then laid flat upon each other, with a strip of parchment, paper, or other similar substance between them, and the whole rolled up and placed in a vessel containing dilute sulphuric acid. When the current of the Gramme machine is sent from plate to plate of this apparatus, the sulphuric acid is decomposed; the hydrogen at the negative plate reduces the lead oxide, and after a time there is left on the surface of the plate a mass of spongy lead. The result of the action at the positive plate is the formation of peroxide of lead, PbO_2, which contains more oxygen than the red oxide, and is, accordingly, more ready to part with it. The final result, therefore, may be said to be chemical separation of oxygen and lead, which involves a certain amount of potential energy.* If the Gramme machine be disconnected we may set the cell aside and keep it for a considerable period, and if at any time we connect the plates by a wire a powerful current will be generated, whose energy may be utilised in a great variety of ways. The percentage of the energy which was originally expended in charging the cell that it will give back in this way is variously stated, but there can be no question that it is really very great. The success of secondary batteries is of great importance to the development of the electric light, especially in the department of domestic lighting. By their use the engines and dynamo machines may be used during the day to oxidise the plates, and the potential energy thus accumulated may be used to light the lamps at night. Such storage can be economically effected and the power transmitted to the point required, wherever such natural sources of energy as waterfalls, high tides, winds, &c., can be utilised. It has been suggested that the enormous powers of the Niagara Falls might thus be brought within the service of man. These accumulators must not be confounded with electro-static accumulators or condensers, although their action is in many respects closely analogous.

[A small accumulator belonging to Mr. J. Y. Buchanan, which had been charged by the Gramme machine a little before, was used to drive the armature of a small Wilde machine.]

ELECTRO-MAGNETIC FORCE, CONVERSION OF ELECTRO-KINETIC INTO MECHANICAL ENERGY.

I now return to the magnetic phenomena which accompany the electric current. My object is to show how the magnetic action can be taken advantage of in converting electro-kinetic energy into mechanical work or the kinetic energy of visible motion, and further to show you that there is here again a notable case of reversion to be seen in the induction of electric currents. Since there is magnetic action through the space surrounding any circuit in which an electric current exists we speak of this space as the magnetic field of the current, and for the same reason we speak of the magnetic field due to an ordinary permanent magnet. An extremely useful method of exploring the magnetic field and of representing its properties was devised by Faraday. If we suspend a small magnetic needle at any point in the magnetic field, and it be so arranged as to be perfectly free to follow the forces acting on it, it will place its axis in the direction of the magnetic force at that point, its north end pointing in the direction in which a north pole taken by itself would tend to move. If we now cause the centre of the needle to move in the direction in which its north end points, and continue to follow the path thus continually indicated, the centre will trace out a line called a line of magnetic force, and if we trace this line both forwards and backwards it will either return into itself or else abut at both ends upon magnetic matter. The positive direction is that in which a north pole would move. We can fill the whole field with such lines, for we can trace one through every point we care to choose.

The fundamental property of such lines is, of course, that at each point their direction is the direction of the magnetic force there.

It is, however, easy to show that they can be so drawn as to represent the magnitude as well as the direction of the force. When they are properly arranged the magnetic force at any point is proportional to the number of the lines that pass through a unit of area placed perpendicular to their average direction. Briefly, the more the lines crowd together the greater the magnetic force.

If a bar of soft iron be placed in the direction of the magnetic force, it becomes temporarily a magnet, with its north pole pointing in the positive direction of the line of force. Advantage has been taken of this to obtain temporary magnets of a size and power not ordinarily obtainable in permanent magnets, as well as small magnets, which can be mag-

* It is, perhaps, scarcely necessary to remind the readers of *The Electrician* that much light has recently been thrown upon the chemical actions that take place in secondary cells, more especially by the beautiful researches of Gladstone and Tribe. [*V. Electrician*, Vol. viii., p. 309.]

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netised and de-magnetised at the will of an operator who may be many miles distant.

[An ordinary electro-magnet was here shown and described.]

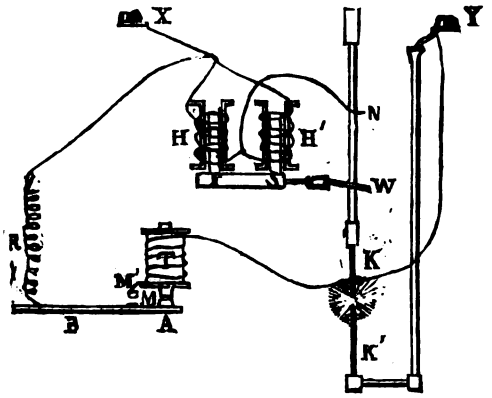
Such magnets are used to an almost endless extent in telegraphy, telephony, for the electric control of clocks, fire alarms, &c. The principle is much the same in all. It will easily be understood by considering this electric bell.

[Large model of electric bell shown and described.]

Regulators for the Electric Light.

In electric lamps of the arc principle it is necessary, as the carbons burn away, to bring them together and so to maintain the length of the arc as constant as possible. Clockwork arrangements were largely used in the older lamps, in which the weakening of the current released the armature of an electro-magnet and allowed the carbons to come together, the motion being so regulated that the positive carbon moved about twice as fast as the negative carbon.

A great defect in these lamps is that, when more lights than one are put in the circuit, the regulation becomes very difficult. The one whose carbons consume fastest becomes the regulator of all the lamps, and, consequently, the action takes place in the other lamps when it is probably not wanted. Mr. C. F. Brush, one of the indomitable American inventors who have lately done so much for applied science, recognising the defects of this kind of lamp, designed another form of lamp in 1876. He overcame the difficulty of regulating the arc by using a differential electro-



Brush Lamp.

magnet. The two terminals of the lamp are represented by X and Y. The current, entering at X, goes through the coils of H H′ in parallel circuit, the outcoming ends being joined and connected to the upper carbon holder N. The upper carbon falls by the action of gravity on to the lower carbon, and when the carbons are in contact the current passes from the upper carbon through the lower carbon and its holder to the terminal Y. The current, however, converts the hollow solenoids H H′ into magnets, which draw into them the iron plungers P S, and lift one edge of the washer clutch W, and so the carbon holder. The stronger the current through H H′ the further are the plungers moved, and hence the carbon. If anything happens to the lamp which interferes with its action provision is made against the accident affecting any other lamp. This is done by means of a short circuiting or cut-out arrangement, consisting of an electromagnet T, wound with a thick and also a fine wire, both in the same direction. When the thick wire circuit of this magnet is complete it short-circuits the lamp, carrying the current to the main circuit. The fine wire coil on T is in circuit with the fine wire of H H′. It follows, then, that by failure of the arc, or by any considerable increase in its resistance, a larger proportion of the current goes through the fine wire coil, increasing the attractive force of T upon its armature A. This armature is attached to the pivoted lever B, which carries a contact point M′. When A is attracted, the contact piece M′ makes contact with M on the coil of thick wire, thus bringing it into circuit. The current then goes from X through the spring R by the contacts M M′, through the thick coil of T to terminal Y, and so on to the main conductor. If this action is caused by the too great length of arc, the current ceases in the coils H H′, the magnet weakens, and the armature drops, allowing the carbon to fall, and, under ordinary circumstances, the lamp is again in action. It will be seen that H H′ act like ordinary magnets. In fact, magnets, whether of the permanent kind or otherwise, are mutually replaceable. We may take an electromagnet without a core, that is, a spirally wound circuit, and it acts substantially like an ordinary electro-magnet or permanent magnet, and is similarly acted upon when placed in the magnetic field. If the principle of the conservation of energy had been known when Lenz announced the law known by his name, "that the direction of the current in the conductor or wire will be such that it resists the motion of the magnet or of the current, or the change in the current, or the change of magnetism," the law might have been deduced from the principle; for since the current flowing in the circuit represents a certain amount of energy, work must have been done to account for it, *i.e.*, the motion of the circuit must have been resisted.

The law of electro-magnetic force as stated by Faraday is as follows :—

Any conductor in which a current is flowing tends to set itself in the magnetic field so that the number of lines of magnetic force passing through it in the positive direction is a maximum.

By the positive direction through a circuit is meant the direction in which a right-handed screw, turning with the current, would progress through it.

If it be remembered that for the present purpose a permanent magnet differs in no way from an electro-magnet, and that, except in respect of power, an electro-magnet is identical in its properties with the spiral current that magnetises it, it will be found that this law furnishes the key to all the complicated pheunomena of magnetic and electromagnetic force. Thus, Faraday's law of electro-magnetic force is the principle that regulates the transformation of electro-kinetic into mechanical energy.

Electro-magnetic Induction.—Conversion of Mechanical into Electro-kinetic Energy.

The reversion of the process we have just described was the great discovery of Faraday. It is embodied in his law of electro-magnetic induction as follows :—

When, owing to the motion of a closed conductor, or for any other reason, the number of lines of magnetic force passing through it in the positive direction varies, a current is induced in it whose electromotive force in the positive direction round the circuit is proportional to the rate of decrease of the number of lines of force.

Soon after Faraday's original discovery, Lenz enunciated the following law, which, although less complete in some respects, is equivalent, so far as it goes, to Faraday's, and is convenient, inasmuch as it brings prominently forward the principle of reversion on which I have already insisted so often :—

"The direction of the induced current is such that the electro-magnetic action thence arising resists the motion that produces the induction."

If the principle of the conservation of energy had been known at the time, Lenz's law might have been deduced as a corallary from it and the law of Electro-magnetic Force ; for since the induced current represents a certain amount of energy, work must have been done to account for it, *i.e.*, the motion that produced it must have been resisted.

We are now in a position to understand the double function of—

Dynamo Machines.

These machines are used—

1. As generators of the electric current.
2. As electro-motors—*i. e.*, as machines for transforming electro-kinetic energy into the energy of visible motion.

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The essential parts of these machines are—
α The field magnets.
β The armature.
γ Collector or commutator.

The current obtained is either alternate as regards sign, or continuous, and hence these machines are sometimes divided into alternate current machines, or continuous current machines. In the dynamo-electric machines the field magnets are electro-magnets, whilst in the magneto-electric machines the field magnets are permanent magnets. The various types of magneto machines may be seen in those designed by Pixii, Saxton, Clarke, Holmes, and recently by De Meritens. It may be interesting, however, to describe one well-known machine as a type of the dynamo. I shall, therefore, ask your attention to that known as the Siemens alternating machine, an illustration of which is shown.

[A brief account was given of the older machine of Siemens, with the permanent magnets, also of Wilde's machine, and his use of an exciter. Reference was made to the almost simultaneous discovery by Siemens, Wheatstone, and Varley, in 1867, of the accumulation or mutual action which is now the basis of many of the newer dynamos. This may be explained, that there is a small amount of residual magnetism in the field magnets, and, upon revolving the armature, a slight current is produced. This current, passing through the coils of the field magnets, intensifies the field, and hence the influence upon the armature, and so on till the field magnets are saturated.

The Gramme and Brush machines were fully described.

An interesting feature in this portion of the lecture was the description of a rough model Gramme machine made by Professor Blyth in the year 1872, with which, in that year, Professor Blyth transmitted power to a considerable distance. The experiments were described in a paper read before the Society of Engineers at Leith, a report of which appeared in the *Scotsman*. In this paper Professor Blyth made the suggestion of utilising the Falls of Niagara by electrical transmission of power, the credit of which has been given to Dr. Siemens, who made it at a later date.

In the lecture, this machine was used to work a lathe upon which was mounted a small circular saw. With this appatus a piece of wood was sawn through before the audience. The power came from Professor Tait's Gramme machine and gas engine some hundred yards off.]

Economies of the Transmission of Power.

Professor Chrystal was unable, owing to want of time, to deliver the portion of the lecture dealing with this part of the subject. The notes, however, which it was intended to follow have been kindly placed at our disposal, and thinking them interesting and suggestive, we may be permitted to give them :—

1. There must be a clear idea of the result that is intended to be produced.

(α) If mechanical work, how many foot-pounds per second, or how many horse-power?

(β) If light, how many candle-power, and how distributed?

2. It must be considered how many hours each day this work is wanted, and this consideration is most important when viewed in connection with the large sums of money that must necessarily be sunk in plant.

3. An important item is "waste"

(α) In the motor, lamp, or emitting machine.

(β) In the transmission.

(γ) In the absorbing machine, say dynamo, and in the motor which drives it.

4. Question as to where the power is to be drawn from? We are thus led into—

(α) The measurement of work done by means of a dynamometer.

(β) The measurement of luminous intensity by means of a photometer in terms of some standard.

(γ) The measurement of electro-kinetic energy absorbed by an electrometer or lamp by means of a galvanometer or electrometer.

(δ) Measurement of electrical resistance.

The chief sources of waste are:—

(α) Friction in the various parts of the machinery, giving rise to useless generation of heat. This is to be diminished by good workmanship and design, and by using the best lubricants.

(β) Heating in the armature of the dynamo owing to its resistance having too large a proportion to that of the external circuit.

(γ) Heating of the field magnets. No greater current should pass through these than just suffices to magnetise them to saturation. The consideration of this question involves discussion of the advantages of using separate exciters, or shunt-wound dynamos.

(δ) The heating from induced currents in masses of metal about the machine.

(ε) The heating of the transmitting conductor. As we have seen, this heating effect is represented by $R C^2$, and can be diminished by diminishing the value of R, that is, by going to more expense, and increasing the size of the conductor. This expense must always be a large item in electric light operations.

The whole energy used and wasted must be furnished by the motive power, be it wind, water, tidal, coal, say as steam or gas power.

Counting the Cost.

1. Interest on prime cost of machinery, dynamos, conductors, and lamps.
2. Deteriorations.
3. Coal or gas, and carbons, or new incandescent lamps.
4. Attendance.

ELECTRICAL INTERCOMMUNICATION ON RAILWAY TRAINS IN MOTION.

BY W. H. FLOYD, M.S.T.E., SUPERINTENDENT OF TELEGRAPHS, GREAT INDIAN PENINSULA RAILWAY.

Although twenty-seven years have passed since the first attempt was made in England to establish an electrical intercommunication on railway trains in motion, and several plans have been brought forward with that object from time to time, it can scarcely be said that any electrical system has been so throughly tried under varied conditions, as to give complete assurance that it may be relied upon to satisfactorily afford communication between passengers, guards, and engine drivers on railway trains in India. The first practical system of electrical intercommunication brought forward in England was introduced by Mr. W. H. Preece in 1864; but, although it was successfully tried on the London and South-Western and other lines of railway, it was prevented from coming into extended use by the preference of railway authorities for the mechanical arrangement known as the "cord" system, which was conditionally sanctioned by the Board of Trade in 1867.

In 1865 the South-Eastern Railway Company adopted an electrical system of intercommunication, introduced by the company's telegraph engineer, Mr. C. V. Walker, and that system has, it is believed, worked satisfactorily ever since under Mr. Walker's supervision.

In the same year Messrs. Varley and Martin patented an electrical system of intercommunication, and the royal train on the London and North-Western Railway line was fitted with it.

A train running daily between London and Wolverhampton was also fitted with this system, which is said to have worked regularly and well for nearly two years. At the end of that time the train was called in for repairs, and its successor was fitted upon the "cord" system.

In 1872 an electrical system was introduced by Colonel Binney on the Great Eastern Railway.

Between 1872 and 1878 no fresh plans were brought forward, and in the latter year it was said that only two systems of the four mentioned remained in practical use—viz., Walker's on the South-Eastern Railway, and Preece's on the London and South-Western.

Since 1878, however, some of the London, Chatham, and

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Dover Railway Company's mail trains have been fitted with Varley and Martin's system.

The Preece, the Walker, and the Varley-Martin systems resemble each other in the particular that with each of them only one insulated wire is employed, the railway metals and screw-coupling drawbars being relied upon to provide a return wire, or earth connection, and they are all worked on the electrical principle that was first applied to this kind of communication by Preece in 1864; but each has a different method of coupling the insulated wire between vehicles, and a different kind of alarm communicator for the use of passengers.

The Preece coupling rope is formed of three stranded copper wires, insulated with india rubber, and covered with a thick plaiting of hemp. This rope is brought from the insulated line wire through the buffer beam of one vehicle, and has at its free end a galvanised iron eye that engages with a gun-metal hook fixed on the buffer beam of the opposite vehicle, and is pressed firmly to it by a strong flat spring.

Each buffer beam has a coupling rope at one end, and a gun-metal hook at the other, both connected to the insulated line wire, so that a double electrical connection is made between vehicles, and the couplings are always ready for joining, no matter which end of a vehicle is presented.

The Walker coupling is a hard brass wire spiral enclosed in a vulcanised india-rubber tube. The spiral has a brass ring at each end, and a brass hook to receive the rings is connected with the insulated line wire, and fixed at the centre of each end of a vehicle near its roof. These couplings are removed at the end of a journey, and transferred to another train, or stored.

The Varley-Martin coupling rope is made by wrapping seven wires round seven hempen cords, each wire round its separate cord, and making them into a rope bound together by two servings of hemp soaked in an insulating compound. Malleable cast-iron eyes are attached at the ends of the connecting ropes, where the couplings are made, and these pass over and are firmly grasped by strong malleable iron hooks actuated by powerful springs placed in cast-iron boxes attached to the carriages. The eyes are coated with copper, and the hooks with brass, at the points of electrical connection.

With this coupling, as with the Preece coupling, a double connection is made between each vehicle.

None of the three couplings described will give any signal in case a portion of a train is separated on a journey, but each inventor has a plan for providing such a signalling arrangement where it is required.

Colonel Binney employed two wires for his system of intercommunication as it was tried on the Great Eastern Railway in 1872. The wires were led over the roofs of the vehicles and connected by a hook and eye and flat spring between them.

Description has been confined to the various kinds of coupling employed by inventors of electrical systems of intercommunication, because the coupling is the only really difficult part of any such system. Once a simple and effective coupling for the insulated wire is secured, it is only necessary, for the establishment of satisfactory intercommunication in a railway train, to have strongly-made bell and battery arrangements that will stand the shaking given to them by the moving train, and to keep the apparatus under efficient supervision.

The method of making the electrical connections to the bells and batteries employed will depend upon what facilities for intercommunication are required.

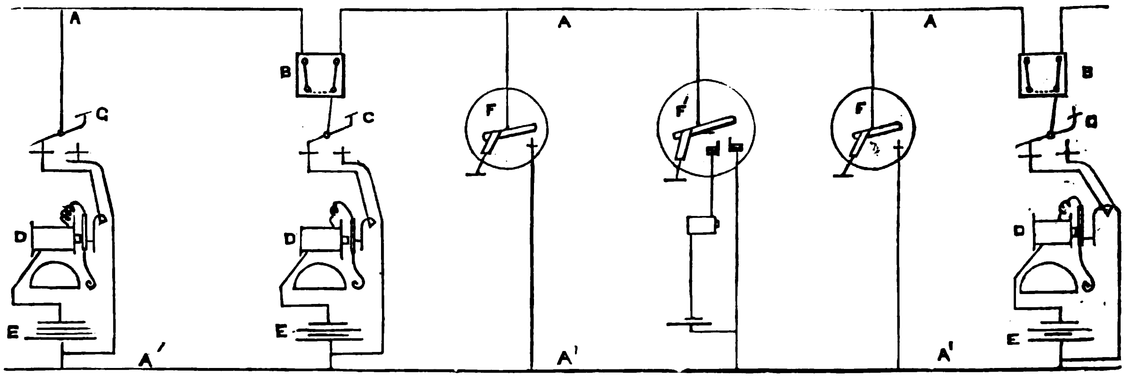
If it is sought only to provide that passengers and guards may ring to the engine driver, an electric bell, without battery or contact maker, will be required on the engine, a battery and contact maker in the front brake van, a contact maker only in the rear brake van, and an "alarm communicator" in each compartment of the carriages whence it is intended that passengers may ring to the engine driver.

But, if it is intended that passengers shall be able to ring to the guards as well as to the engine driver, that guard may ring to guard, or driver, and that the driver may ring to the guards, it will be necessary to have an electric bell battery and contact maker on the engine and in each guard's brake van, as well as an "alarm communicator" in any compartment of a carriage whence passengers are to be allowed to ring the bells.

This plan is illustrated in the figure below, together with a method proposed by the writer for connecting an indicating bell to direct the guards to the compartment of a carriage whence an alarm has originated. A train composed of an engine, thirteen passenger coaches, and two brake vans has been fitted up on the Great Indian Peninsula Railway in the manner shown by the diagram, and is running daily on the local service between Bombay and Kalyan, in order to ascertain by experiment whether an electrical system of intercommunication will meet the requirements of Indian Railway traffic; and to practically test a form of coupling for connecting the necessary insulated wire between carriages, and an "alarm communicator" recently designed and patented by the writer.

Diagram showing Electrical Connections in a Train composed of one engine, two brake vans, and three carriages. Centre carriage fitted with local bell and battery to indicate where alarm originated.

FIG I



A Line Wire. A' Return, or Earth Wire. B Switch. C Contact Maker. D Electric Bell. E Battery. F Alarm Communicator for carriage *not* fitted with local indicating bell and battery. F' Alarm Communicator fitted with Local Indicating Bell and Battery.

The coupling now under trial upon the Great Indian Peninsula Railway was designed especially with a view to suit trains that have their composition varied many times during a journey, as is the case with the mail and other through trains upon that line. With such trains the risk that a shunting porter may forget to unhitch anything that will not prevent vehicles from separating, is repeated so often during the run of a train, that it is very important to have the electrical coupling for intercommunication purposes so arranged that if the shunter should forget to cast it loose it will become uncoupled immediately one vehicle moves away from another, and will not become damaged in the process.

The coupling (Fig. 2) is formed by two pieces of metal tube, each 3 inches in length and $1\frac{1}{4}$ inch in diameter, and closed at one end. A strong flat spring, fixed at the closed end of each piece of tube, projects half an inch beyond the

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open end, and carries at its free extremity a wedge-shaped piece of metal.

When two pieces of tube are brought together, and one wedge-shaped piece is forced over the other, as shown in Fig. 2, a good electrical contact is made, and the coupling is complete.

There is a slotted piece on one side, and a stud on the other, of each piece of tube to act as guides and to prevent any circular movement of the parts after they have been connected.

The insulated line wire is fastened to a ring at each end of the complete coupling, and is carried thence to the centre of the width of the carriages at such a height as to be well clear of the screw couplings and side chains of the vehicles. The coupling hangs in the centre of the space between two vehicles, and can only be separated by a direct strain. The amount of the strain required may be regulated by the strength of the springs in the tubes, and the shape of the wedge piece. The couplings employed on the Great Indian Peninsula train separate at a direct pull of 20lb.

For the return, or earth, wire the writer prefers to use the permanent way rails connected *viâ* the wheels of the vehicles of the train, and supplemented by the screw coupling draw-bars joined together underneath each carriage by wire spirals, but if such an arrangement should prove to be unreliable in India, as has been suggested—although it has been found perfectly reliable in England for the past 16 years—the coupling under description may be readily made to couple up a return wire as well as the insulated line wire. For this purpose it will only be necessary to fasten the fixed end of the flat spring of each piece of tube in a block of ebonite instead of in metal, thus insulating the spring from the tube. Then the spring will couple the insulated line wire; and the metal case, slotted pieces, and studs of the tubing will couple

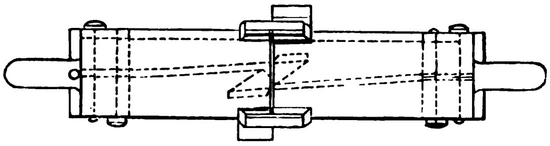

FIG. 2

Coupling to connect insulated line wire between vehicles.

the return wire; thus the rails of the permanent way will no longer be required to complete the electrical circuit. In connection with most of the electrical systems that have been brought forward provision has been made for giving a signal in case any part of a train should become separated, but, so far as the writer is aware, none of the plans for that purpose have been brought into practical use upon railways. It is an objection to such a signal that unless some more or less complicated machinery is added to the ordinary electrical apparatus employed in intercommunication systems, the signal given when part of a train breaks away must of necessity appear to engine drivers and guards exactly like the signal given by a passenger whose "alarm communicator" is intended to give a peremptory order to stop the train; therefore there would be risk that the train might be stopped by a break-away-signal being mistaken for a passenger's signal, and a collision might result from the hinder part of the train that had separated running into the foremost part. Such liability to mistake, and consequent danger, might perhaps be prevented by some such arrangement as the following:—

In each carriage have a train of clockwork to drive a small wheel that has parts of its periphery insulated, and parts making rubbing contact with a flat spring, every time the wheel revolves. Connect the wheel and spring in the intercommunication circuit.

Arrange passenger's "alarm communicators" in each carriage, so that any one of them will start the train of clockwork when a passenger gives an alarm signal. Then the ringing of the bells on the engine, and in the guards' brake vans, instead of being continuous will be interrupted at regular intervals, and thus clearly show that the alarm signal has been given by a passenger.

Each carriage may have the periphery of its clockwork wheel differently insulated from the others, so that signals given by passengers will not only be identified as such, but the particular carriage that a signal comes from will also be told to driver and guards.

But such a plan would be somewhat expensive, and would introduce complication where extreme simplicity is much to be desired. As, however, railway authorities who regard a break-away-signal as an important requirement of an electrical intercommunication system in trains, may see some way of overcoming the difficulty proceeding from similarity of signals without incurring serious expense, or introducing complications, the writer has devised an adaptation of his coupling that provides for a continuous signal, identical with that given by a passenger, being given if any part of a train should become separated on a journey.

In this adaptation of the coupling the springs are insulated from the tubes, as before described so that neither the permanent-way rails nor the screw couplings are brought into use to complete the electrical circuit for the intercommunication, and a small lever is so arranged in each piece of tube that it is insulated from the wedge-shaped piece on the flat spring as long as the coupling remains connected up, but immediately the coupling is separated, the small lever is forced hard on to the wedge

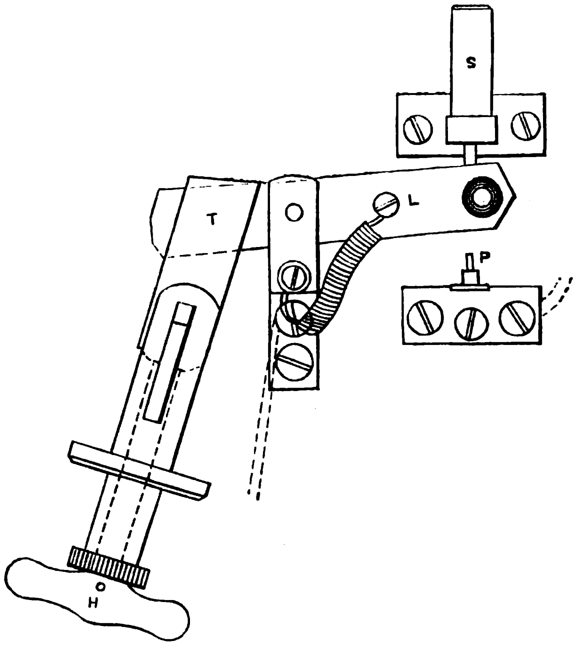

FIG. 3.—Alarm Communicator.

piece, and makes full contact between the insulated flat spring connected to the line wire, and the metal case, slotted pieces, and studs connected with the return wire. Thus the bells on the engine, and in both guards' brake vans, will ring continuously, precisely as they would do if a passenger had given an alarm. It is claimed for the coupling described above that it is simple in construction and very strong, that it may be made of inexpensive materials—the cases may be of iron gas-pipe if desired—that it assures perfectly safe electrical contacts which are cleaned by the separation, or re-connection, of the coupling—that it may be used either with or without employing the rails of the permanent way for a return wire, and that it may be readily adapted to giving an alarm in case part of a train should become separated on its journey.

Also that, by means of spare lengths of insulated wire rope having a half coupling at each end, any number of vehicles not fitted with the electrical intercommunication system may be bridged over, so that they will not interfere with signals passing through the electrically fitted portion of the train; and that any description of rolling stock may be fitted with the electric rope and couplings as quickly as it could be fitted with the "cord," so that railway companies employing the writer's system need only have electric ropes

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permanently fixed to stock that is constantly running, or that is required to be provided with alarm communicators for the use of passengers; vehicles only occasionally running remaining unfitted with electric ropes and couplings, except when they are actually in work.

The "alarm communicator," Fig. 3, to be fixed in railway carriages for the use of passengers, has a neat teakwood case—not shown in the figure—from which only the cross-piece H projects. A passenger having pulled this cross-piece downwards once, the tongue T is removed from a slot on the lever L, and the latter, being released, falls upon the contact point P, assisted thereto by the helical spring enclosed in the tube S, thus connecting the line wire with the return wire or earth (see Fig. 1) and causing the bells on the engine and in the brake vans to ring continuously until the guard unlocks the teakwood case and restores the lever and handle to their normal positions. The passenger cannot put the handle back until the case has been unlocked, because the tongue T cannot enter the slot on the lever L until the latter has been lifted clear of P.

In case it is required to have an indicator to direct the guards to the particular carriage whence an alarm has been given, the "alarm communicator" lever L is slightly lengthened, and an additional contact point is placed alongside P, but insulated from it—this extra contact point connects with a small electric bell, and thence with a battery that is connected with P (see Fig. 1). Then when a passenger releases the lever L, it falls on both contact points, thus establishing its own circuit as already described, and also completing a local circuit that causes the small bell in the carriage to ring out a direction to a guard passing alongside the train as to where he should look for the originator of the alarm signal.

The switch shown in each brake van (Fig. 1) is to enable the front guard to communicate with the engine driver only, without ringing the rear brake van bell, or to communicate with the rear guard only, without ringing the engine bell. For the former purpose he disconnects the bar nearest to the rear of the train from its lower terminal, and keeps the bar nearest to the engine connected up as shown in the diagram, and for the latter purpose he disconnects the bar nearest to the engine, and keeps the bar nearest to the rear of the train connected up. The switch is only required in the front brake van, but as any brake van may be placed in front of a train, it is necessary to fit every vehicle of that class with a switch.

[The above has been taken from a pamphlet forwarded to us by the author.—Ed. *E.*]

GALVANOMETERS.

BY J. T. SPRAGUE.

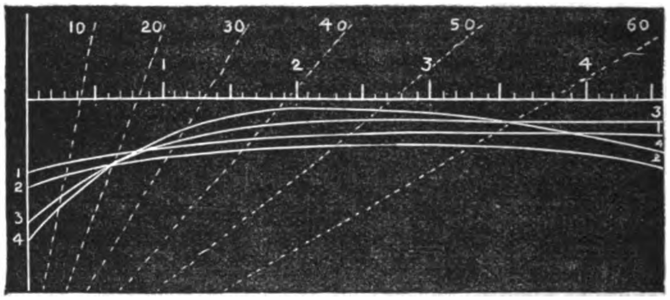
It is evident from the curves of action, shown p. 465, that no simple law can be formulated showing the ratio of the value of deflections; yet it is certain that a law does govern them, but the formula must take into account the position of each single turn of wire. But a line can be ascertained by experiment which fulfils the part in these instruments of the line of tangents in the more perfect form, this line being a curve varying with the positions of the wires. This (which has never before been described to my knowledge) is the plan I devised for calibrating galvanometers. By placing the instrument in circuit with a tangent galvanometer graduated in amperes, I obtain a series of corresponding deflections which I transfer as radial lines upon a paper mounted upon a table having a large quadrant drawn upon it, and fitted with an arm working on a centre pin. Knowing approximately what the curve will be, I run a pair of compasses, open to a suitable space, over these lines, and thus obtain a curved line, which can then be divided into equal parts, and which acts as a scale, several feet in length, from which, by means of the radial bar, the actual dial of the galvanometer is easily and correctly drawn.

The figure shows a set of curves thus obtained for an instrument having four circuits, consisting of

No. 4	......	900 turns	No. 26	cotton covered wire.
3	......	90 „	18	„ „
2	......	9· „	18	„ doubled.
1	......	1· „		sheet copper.

The whole being continuous, this gives four circuits of 1, 10, 100, 1000 turns, so arranged as to have approximately equal actions, and gives reading of current from 10 amperes to ·0001. In this instrument there was a wide opening in the middle, and the effect is shown in curve 4, which is that of the circuit closest to the needle. Where the curve rises the current has least power. The curve shows also by its rapid fall beyond 50deg. that the layer of wire does not extend far enough away from the needle to compensate for the closeness of the wire. Curve 3 shows the effect of increasing distance, by flattening the curve, a process carried much further in curve 2. Curve 1 shows the effect of increased distance in doing away with the effect of the middle opening, and also in utilising the outer portion of the plate of metal filling the space devoted to that circuit. It shows clearly that at a further distance the curve would flatten down into the simple tangent line, which would be the same thing as the scale of equal parts shown, which represents the indication of amperes on curve 1, and of the corresponding decimal submultiples upon the other curves. It should be understood that an unsatisfactory instrument is here selected, because of the lessons it teaches, and because on this small scale good curves would run into each other too much.

It is a remarkable circumstance that no electrical text-book or teacher has shown that galvanometers show the resistance



of the circuit as well as the current passing, provided the electromotive force is known. Yet many galvanometers have been made graduated for resistance, and the system was patented by me seven years ago. As current and resistance are linked together by a defined law, they being inverse to each other, as $\frac{E}{R} = C$, and $\frac{E}{C} = R$, so also, as in a tangent galvanometer, C varies as *the tangent of the angle*, it follows that the resistance varies as the *co-tangent of the angle.* Therefore, as the line of graduation for current originates at the zero line, or at 0°, so also a true line of graduation for resistance originates at 90deg., the graduation of that line depending on the E.M.F. producing the current. Therefore, if a known and reproducible force is employed the instrument can be graduated to show resistance in ohms as well as current in amperes. The only force at present available for the purpose is that of the Daniell cell.

It should be understood, however, that such a graduation remains correct only on condition that the magnetic force acting on the needle remains constant. Therefore it is not available with a pair of opposed needles controlled by a mechanical resistance, nor in the case of a single needle when the horizontal component of the earth's magnetic field is altered either by change of locality or by the neighbourhood of magnetic bodies or electric currents. When a galvanometer graduated in one place is removed to another in which the strength of the earth's field is different, the readings require a correction, or the graduation may be regarded as a mere scale of equal parts, and the actual value of the unit deflection be represented by a constant, as is the usual practice with tangent and sine galvanometers.

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ELECTRIC LIGHT AND VENTILATION AT THE BIRMINGHAM MUSICAL FESTIVAL.

The *Journal of Gas Lighting*, in a recent issue, made the following comments upon the striking improvement in the comfort of the audience at the Town Hall:—

"Sufficient misuse has already been made of Lieut.-Colonel Festing's economical triumph in the so-called lighting of the South Kensington Museum by electric lamps, as compared with the previous gas lighting; but it is possible that recent experiences at the Birmingham Town Hall may be similarly misinterpreted by electric lighting partisans. It has been widely admitted that the state of the atmosphere of the Hall during the recent Musical Festival was greatly superior to that observed on previous occasions of the same kind. This time the hall was lighted by incandescent electric lamps, and the improved effect was, of course, wholly set down to the change to this system from the foul, polluting, suffocating combustible supplied by the Corporation Gas Works. This was a great lift for electricity, and a great discredit to gas, so long as the first crude results remained without other explanation. Something has since been stated, however, which the audience at the Festival could not be expected to know—namely, that, in view of the event, a thorough overhauling and re-arrangement had been made of the ventilation of the hall. Previously the fresh air inlets were very inadequate, and generally took the form of draughts; while the openings in the ceiling for the escape of hot and vitiated air were only competent to discharge the contents of the hall once in every four hours. Added to this, the heating arrangement consisted in warming air taken from the hall and returning it again, instead of admitting a fresh allowance from without. Now, however, by new ventilators making use of currents induced by gas jets, the atmosphere of the hall is changed completely every half hour; and thus the highest temperature under the ceiling is easily kept about 40deg. lower than before. The superior comfort of the audience at the festival is thus easily accounted for without ascribing to electric lighting a virtue which it does not possess. Indeed, it will be seen that the vilified gas is one of the principal agents in effecting the beneficial change in question. It will only be following established usage, however, if in future all the credit of supplying fresh air to the Birmingham Town Hall is appropriated by the electricians, without a word of acknowledgment to the ventilating engineers, but for whom the atmosphere of the hall would have remained as foul with incandescent lamps as it used to be with gas."

Upon this Mr. Lea, the engineer in charge of the works, has replied by the letters which we give below. The comparative experiments he furnishes effectively dispose of the matter, but the absurdity of the assertion that but for the changes in the ventilating arrangements of the hall itself the atmosphere "would have remained as foul with incandescent lamps as it used to be with gas" is obvious. The two circumstances noted in our report, that the heat was actually greater on the floor than under the ceiling, and that the breathing conditions were better at the top of the organ than anywhere else, speak for themselves. Such conditions have never been before realised in a crowded public building. We noticed also the effect upon the tuning of the organ, and at an evening performance given in connection with the lighting Mr. Stimpson, the organist, came forward and stated that he had never known the organ to act so satisfactorily. He said that he had been able to use for the first time for many years a part of the organ which on all other occasions he was debarred from employing in the evening because the difference of temperature at the top and bottom of the organ put this part out of tune:—

"To the Editor of the *Journal of Gas Lighting.*

"Sir: Your remarks last week upon the electric lighting of the Birmingham Town Hall are, I venture to think, somewhat unfair. You charge the electricians with having unjustly appropriated to themselves the credit of rendering the hall, during the evening concerts, cooler and purer than it has ever been on similar occasions, and you conclude by saying that but for the ventilating engineers the 'atmosphere of the hall would have remained as foul with incandescent lamps as it used to be with gas.'

"On behalf of my clients, Messrs. R. W. Winfield and Co., and of Messrs. R. E. Crompton and Co., and myself, I beg you in common fairness to allow me to state that we have no such intentions as those you impute to us, and that the facts are directly at variance with the views which you express.

"On the 22nd August I conducted an experiment in which the hall was lighted by gas for three hours, namely, from 5 p.m. to 8 p.m., the windows and doors being closed, the new fresh air channels being open, and the gas burners within the ventilating extraction shafts being in full operation. The hall was unoccupied excepting by those engaged in preparing it for the festival. At the end of the experiment the temperature near the ceiling over the orchestra was 35deg. higher, and over the great gallery 38deg. higher, than at the beginning.

"At 9ft. above the floor the temperature had risen 5deg. Ascending the ladders at the back of the organ one entered a hot and stifling atmosphere, which became worse as one rose until at the top of the organ it was almost unbearable from its foulness and its heat.

"On the following day, under precisely similar conditions of windows, doors, fresh air channels, extraction shafts, external temperature, and occupants, the electric light was kept in full operation for seven hours, namely, from 4 p.m. to 11 p.m., and the temperature rose over the orchestra $1\frac{1}{2}$deg. and over the great gallery 2deg. At 9ft. above the floor the temperature rose $1\frac{1}{2}$deg. The atmosphere at the top of the organ was as pure and pleasant to breathe as that on the floor or at any other part of the hall.

"Thus, after a period of lighting by electricity 2·33 times as long as by gas the temperature at the ceiling was increased only $\frac{1}{18}$th of the amount due to the gas.

"It will not be disputed that the combustion of carburetted hydrogen gas produces both heat and carbonic acid gas, or that the latter is poisonous to human beings. On the other hand, it cannot be denied that the Swan incandescent electric lamp is powerless to vitiate atmospheric air to any extent whatever, and it is easily proved by an experiment which I should be happy to perform in your presence, that the heat from an incandescent lamp is less than 10 per cent. of the heat from an ordinary jet of gas of equal candle-power.

"There are 800 jets in the Town Hall, consuming 2,800 cubic of gas per hour.

"It needs no argument to connect these facts with the increased purity and coolness of the hall during the aforesaid electric light experiment, and during the festival week.

"That Mr. Cox, the ventilating engineer, has improved the arrangements for both ventilating and warming the hall is not disputed by any one who has been connected with the electric lighting of the hall. On the contrary, his work is thoroughly appreciated by us.

"That Mr. Cox does not claim for his alterations the extraordinary value which you attached to them is evident from the enclosed letter with which he has kindly favoured me. Trusting to your courtesy to insert both his letter and my own in your next impression.—Yours, &c.,

"Henry Lea, Consulting Engineer.

"38, Bennett's-hill, Birmingham, September, 1882."

"Borough of Birmingham, Baths Department,
"Kent-street, Sept. 23, 1882.
"Town Hall.

"Dear Sir: In reply to your letter dated September 22, having reference to the report on the electric lighting and the ventilation, as appeared in the gas journal, I beg to say that the very small increase in the temperatures during the evening performance, as compared with the morning temperatures, were in my opinion due to the slight radiation of heat from the electric light as compared with the heat generated by the present system of gas lighting of the hall.—Yours, &c.,

"(Signed) J. Cox, Engineer.

"Mr. Henry Lea, Engineer."

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WINTER STUDIES.

Last week we spoke of the indications of a new industry springing up consequent upon the threatening attitude of the burglar. This week we may more hopefully speak of new studies arising out of the threatening aspect of trade. If novelties in the way of electrical appliances are everywhere to be seen in our shop windows, a not less novel spectacle presents itself on our hoardings and dead walls. Technical education is evidently in the ascendant, for we see it placarded on posters in the public thoroughfares as well as advertised in our public newspapers. One of the best remedies, it is thought, for our failing manufactures—if, indeed, it be true that they are failing—is that our handicraftsmen should master the technical part of their callings. Other causes may be, and no doubt are, operating adversely on the trade and industry of this country, but this one, the want of technically skilled labour, is by common consent considered to be among the foremost. It is, therefore, with much satisfaction that we notice a very exceptional awakening in that respect, and evidence of a plentiful supply this winter of the means for acquiring such technical skill. The various educational establishments which are actually colleges, or by courtesy are so called, in the metropolis as well as throughout the provinces, are putting forward pressing invitations on this particular subject, and we may reasonably hope that the response will be equally cordial.

Gratifying as are these indications to the social scientist, the economist, the commercial man, and the manufacturer, one feature connected with them is especially so to that branch of science with which we are most intimately connected. On the programmes of every one of these scholastic institutes, electricity, and the several branches of study to which it has given rise occupy a prominent place; and among the evening classes those devoted to the teaching of electrical science, both theoretical and applied, are very numerously represented. Evidently the value of this kind of knowledge is growing in public estimation, or the supply would not be so liberal.

At the various manufacturing works, also, connected with electrical industry, there is, we have reason to believe, a great demand for the admission of students and apprentices to learn the business. This is not confined to the cable works and what go by the name of "telegraph construction" establishments, but extends to electric lighting firms, telephone companies, electro-plating works, and largely also to the makers of electrical apparatus. Formerly the chief outlet for any special aptitudes or enthusiasms in the field of electricity was in the service of some telegraph company, or at best, in that of a submarine cable manufacturer. But manifestly the telegraph has no longer the pick of such eligible persons at its command. Fresh openings are presenting themselves in a multitude of directions where electricity has been brought into requisition. Gentlemen who have given their sons a liberal education are beginning to turn their eyes in the direction of electrical engineering as a profession for them, and are coming to regard it as they used to do that of the civil engineer.

To meet this new demand we are glad to notice that not only are the humbler educational establishments of the evening class type bestirring themselves, but that colleges of higher standing are taking a prominent lead. As instances of this we may point to Dr. Lodge's work at Liverpool University College; Professor Silvanus Thompson's at Bristol University College; and Professor Adams's at King's College in London. The example of such men as these is sure to prove infectious, and what is of quite as much importance, the method of instruction is certain to be set on a proper footing. The teaching at many places has been, and perhaps continues to be, mere play—instructive play, certainly, but still play directed to no practical object, unless the passing of a paper examination can be called an object of the practical sort. Still worse was the system, which we hope survives nowhere, of teaching from books a set lesson. No physical science can be taught from books, any more than can a handicraft be taught by them. Practical demonstration, and something which may be fairly designated a real experience, are necessary in most such studies, and in that of electricity they are absolutely indispensable. These will be supplied by teachers such as we have named, and the system which they

will inaugurate is sure to be imitated by their humbler followers elsewhere.

Of course a large amount of the extra attraction towards electrical studies, to which we are here referring, is directly due to the interest universally aroused in electric lighting; but the public in this relation are guided by a true instinct. They see in a more conspicuous way than was ever presented to them by the electric telegraph that electricity is a great force as well as a useful messenger; that it will become a power as well as a convenience; and they rightly calculate that a great and remunerative profession is open to such as have a mind for it in the not very distant future. We sincerely trust that the training which is now largely advertised as ready to be given during the forthcoming winter months will redeem the promises held out, and that the public, who are expecting great things from the acquisition of electrical technical knowledge, will have no reason to find fault with the results.

A GUIDE TO PRACTICE IN THE SUBMARINE CABLE TESTING ROOM.

III.

The student will probably ask himself the question, "What does taking a copper resistance test mean?" The answer would seem naturally to be, "Measuring the resistance which the conductor of the cable offers to the passage of an electric current." So far right; but in so doing we also measure or determine its temperature. The two chief points to be borne in mind here are, first, that the resistance varies directly as the length, increasing when this is increased, and *vice versâ*, and, secondly, the temperature influences the resistance, increasing it as itself rises. This latter point, though a very elementary one, is not always at the moment remembered. A beginner finding the same length of cable giving different resistance on different days would think something was wrong if he had not kept this fact in his mind. Moreover, the temperature of the air as marked by a thermometer in the testing room may not, indeed would not, be the same as that of the cable, nearly all of which is in its tank. Then, again, as part of the section is core (at least while the sheathing machine is running), the temperature of the section may not be uniform; the core tanks may be warmer than the cable tanks. When we come to the working out of the test it will be seen that this fact of copper resistance increasing with increase of temperature enables us to calculate the resistance for any required temperature, thus reducing all tests to one standard. This caution is given at the outset as essential from the first.

A very few words suffice for the actual operation of taking the test. The length and mean resistance per knot of the cable is known, being recorded in the test books. The whole resistance of the section to be tested is therefore easily estimated, and the plugs in variable arm D E (Fig. 1, p. 474) are arranged according to the ratio previously fixed in the two arms of the balance A C, C B. If this be 10 to 1,000, then 100 times the amount of the cable resistance must be unplugged. If this resistance were as much as 100 units, or any sum under 1,000, the balance ratio must be 100 to 1,000, and if 1,000 or under 10,000, the balance ratio must be equal, as 1,000 in each arm. The battery key, H for zinc, or I for copper, is now depressed, and this should always be done before putting down the galvanometer key P Q. This latter key, as can be seen at a glance, is merely a short-circuiting arrangement for the galvanometer. Perhaps we ought to say this means a path of no resistance for the current, which thus cannot pass through the coils until the path be removed. In using this key to try if there is a perfect balance, after unplugging the variable resistance, it should be lightly handled at first, until the result is obtained, when it may be firmly pressed down, and if the mirror gives no deflection the proper proportion has been found. The amount unplugged will be a hundred times the resistance of the cable (supposing the balance ratio were 10 to 1,000).

As each cable must be "put on" or connected to the board (through plugging in the commutator if leads are used), the test should not be attempted until this is believed to have been properly done. Though the leads may be connected to the terminals, there may be disconnection outside at the tank. But if there is a doubt on the point, or, if after unplugging the required amount of resistance in the variable arm D E, a considerable deflection is seen on that side of the scale which shows that more still is required, the 5,000 plug should be removed (if not already out), and, if yet more is necessary, the cable is most probably not joined up. In all patterns of the bridge there is an arrangement for breaking or opening the circuit either by taking out a plug or disconnecting a bar, thus making the resistance infinite. The term "infinity," when relating to electrical resistance, means, strictly speaking, the resistance of the atmosphere. This plan can be followed if required in the case just mentioned.

The following points must be attended to:—The leads must be firmly connected to their terminals, and all the plugs that are inserted must be tight in their places. The holes or spaces between the bridge coils should be clean lest any kind of matter should reach across from one brass block to the other. If any plug be loose, a varying resistance is constantly interfering with the circuit, when the current is passing, and a true balance will not be secured. The point where the galvanometer key P Q presses against its upper bar should be cleaned pretty often by placing a piece of white paper between and pressing the key upwards against the bar. The operator may sometimes see that a current is affecting the galvanometer, though the key is not down. This is caused by the existence of dirt between the contact points, thus causing resistance and preventing the bar from acting as a short circuit. Before commencing the operator should look carefully round and see if anything is wrong, such as a plug out of place. The plug below the figure 3, joining the short-circuit key to the galvanometer terminal, should be noted, for sometimes it is shifted and its absence only discovered after loss of time. Care should also be taken that there is no plug between 2 and 3 (Fig. 1), or the galvanometer would be short-circuited even if the key were depressed.

The little box, 4 and 5 (Fig. 1), from which the leads go direct to the galvanometer is a shunt, to be used when it is found difficult or impossible to get a steady balance. This trouble may arise from different causes. Sometimes the machine on which the cable is being sheathed causes it, and sometimes a machine sheathing other sections does so. Sometimes it is due to the fact that cable is being coiled out of the tank in which the section under test is lying (as a finished piece). The result is the existence of induction; disturbing resistance is produced in either case. When this happens a plug must be inserted in one of the shunt holes, when part of the current is shunted off from the galvanometer, and a balance is more easily arrived at. But, if possible, this should be achieved without using the shunt, and it can be tried after balancing whether this can be dispensed with. In any case the shunt plug should be removed after the test, lest it be forgotten and left to affect the next one. If the disturbance appears too great to enable the operator to determine the question as to balance by noticing an equal deflection on both sides of the zero or centre point, the machine sheathing the section must be stopped; but this should only be done in extreme cases, and very rarely. It is most important that the machines should be allowed to work with the least possible interruption, and they should on no account whatever be stopped except under circumstances of absolute necessity.

A word more about the use of the shunt in this test. The learner will find it stated in all descriptions of this instrument that, as it takes off a part of the current from the galvanometer, acting as a branch resistance, it is necessary to multiply the value of the deflection by the multiplying power, or that figure representing the proportion in which the current through the galvanometer is lessened. And this is the case in nearly all instances of its employment; but in the bridge test no account is taken of the division of the cur-

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rent, since a balance only between two circuits is wanted, and both sides are equally affected by the shunt.

In the bridge arrangement now being discussed the resistance coils are connected in a series, each to one of the brass blocks, any two of which are joined by the plug when inserted. Plugging in, therefore, decreases the resistance of the circuit, and unplugging increases it. This plan is also followed in another and, perhaps, more generally seen form of bridge, which we must mention (see Fig. 3). In this arrangement we have three out of the four arms in one apparatus or box. Here C B and C A are the two arms of the balance, and D and E are the terminals of the variable arm; the connection between A and D

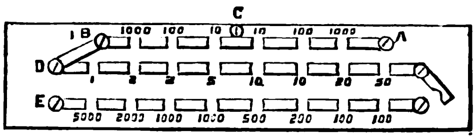

FIG. 3.—Bridge and Resistance Box.

is in some patterns out of sight. The mode of joining up for testing is easily seen by a glance at the first two figures (p. 474), for they are marked with similar letters. The figures stamped on the boxes close to each brass piece covering the resistance coil below it represent the value in units (generally ohms), and since, as before-mentioned, each coil is connected between two of these, if the plug be taken out, that particular amount of resistance comes in circuit, as, for example, at 10 the coil has 10 units, at 100 the coil has 100, and so on. But this is not the case with all resistance boxes, some of which have figures marked against the coils which represent the *sum* of the resistances brought into the circuit by several coils, all

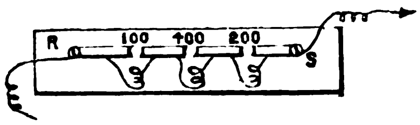

FIG. 4.—Resistance Coils. Plugs out for adding Resistance.

of one value. There is a third form of Wheatstone bridge arrangement which is preferred by some electricians to those above mentioned. There are advantages on both sides, but we shall not pretend to decide which is best. In this arrangement the coils in the variable arm are so connected that plugging in increases the resistance in circuit and unplugging does just the reverse. This is done by having the coils arranged on the principle last noticed. The hundreds, for example, are marked from 1 to 9, each coil having the same value, and if three, four, or any number of hundreds is wanted, the plug is inserted at 3, 4, or whatever it may be—say 4. Then the coils 1, 2, 3 and 4 are brought in circuit by the plug connecting the 4th to the terminal or piece communi-

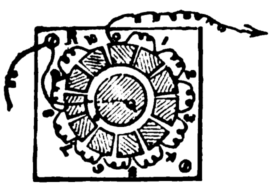

FIG. 5.—Resistance Coils. Plug in for adding Resistance.

cating with the rest of the circuit, which is increased by 400 units. The thousands, hundreds, tens, and single units are all separately joined on this principle, and for each set there is a plug hole, marked O, showing there is no coil there. See Fig. 4 and 5. Here we find the two forms compared or contrasted. In Fig. 4 each coil has the resistance marked, and, all the plugs being out, a current traversing them encounters 700 units resistance. In Fig. 5 also 700 units are in circuit, but each coil being 100, it requires seven of them to make the sum, and the plug inserted at the seventh connects 700 units to the circuit. In each case a current is supposed to enter at R and pass through. The main difference between this form and the other two lies in the fact that in the latter the amount of resistance marked is really at the place indicated, and in the former it is only summed up at that point. The one claims to complete a value, the other to be that amount in fact.

The bridge can be employed for other tests as well as that for conductive resistance of the copper wire, in connection with which also it is very useful in fault testing. It can also be used as a convenient resistance box or as a shunt. There are many points connected with its employment which do not come within the limits of our purpose, such as the selection of the best values for the ratios under different conditions of test, &c., for which we recommend a careful study of Kemp's work on testing or Schwendler's book on that and kindred subjects.

We do not think it necessary to say anything more at present about the bridge, and shall pass to another subject. The working out of the test will most conveniently claim our notice when we have other tests also to apply.

One last caution we consider ought to be impressed, and the offer needs no apology as being in the student's interest. We advise him not to attempt too much in the study of theory before mastering some considerable amount of practice. Or, at least, not to think he has a perfect knowledge of any part of electrical science because he can refer to certain laws by name and knows something of the formulæ.

The hints contained in the foregoing matter are considered sufficient for circumstances in which everything is straightforward and all the conditions exist exactly as they appear to be.

VARLEY'S TELEPHONE IMPROVEMENTS.

Mr. C. F. Varley is a pioneer in telephony, and will be regarded by and by as the Reis of harmonic telegraphy. His 1870 patent for "cymapheus," or instruments for communicating musical messages by electricity, is the forerunner of Elisha Gray's later patents. That patent came to no permanent practical result, at least as far as the cymaphens were concerned; but in a recent patent (No. 5,688 for 1881) we have this inventor, in conjunction with his brother, Mr. F. H. Varley, resuming his telephonic studies, and protecting a series of microphone transmitters and electro-magnetic receivers, which form a complete telephonic system. The most interesting parts of the new apparatus are the transmitters, to which several ingenious magnetic and electro-magnetic adjustments have been applied.

We shall illustrate one or two of the most interesting of these improved microphones. Fig. 1 is a case in which a permanent magnet, N S, is employed to regulate the pressure between the two conductors forming the microphonic joint.

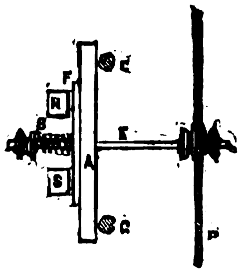

FIG. 1.

This joint subsists between the carbon pieces C C′ and the cross piece, which is connected to the diaphragm by a stem E. A piece of soft iron, or armature, F, is attached to the back of the cross-piece, and behind it is placed the small bar magnet N S. A regulating screw, B, completes the device, and applies a certain pressure to the cross-piece A, causing it to bear upon the carbon pieces C C′. This pressure can, however, be delicately adjusted by shifting the magnet N S into greater or less proximity to the armature F.

Fig. 2 represents a transmitter in which but one microphonic contact exists between the pieces A and C. Here N is

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the pole of a magnet, to which is attached a movable arm, N, carrying a contact piece, A. This arm is a movable prolongation of the magnetic pole N. It is obvious, therefore, that if the diaphragm D be made of iron, steel, or nickel, so as to be magnetic when moved toward N, the attraction

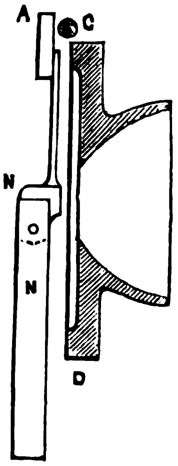

FIG. 2.

between it and the magnetised arm will become more powerful, and the pressure between A and C will be increased. On the contrary, if the diaphragm recedes, the pressure decreases, and thus the vibration of the diaphragm D is made to enhance

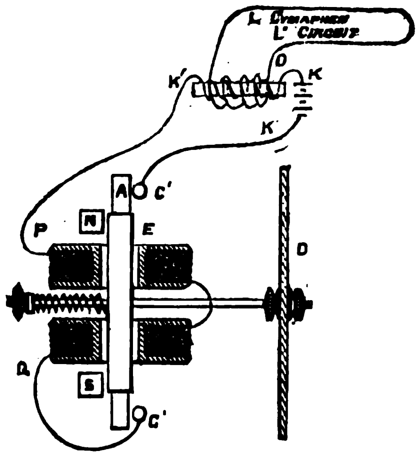

FIG. 3.

by means of magnetism the corresponding variations of pressure at the microphonic contact.

Fig. 3 shows another plan, in which electro-magnetism plays a part instead of permanent magnetism. Here the

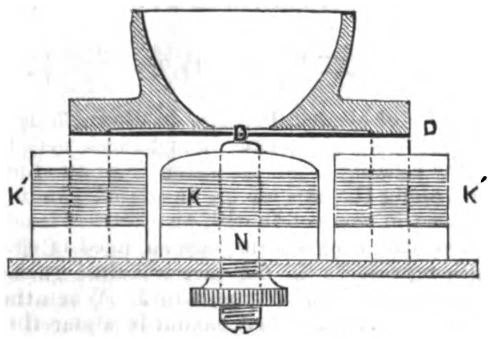

FIG. 4.

cross-bar A, with its armature, is suspended between two coils or helices. The current from the battery passes through the primary of an induction coil, O, through these helices, P and Q, and across the microphonic contacts between the cross-bar A and the pieces C C'. The current in the helices magnetises the armature in the same direction as the poles of the magnet N S. If, then, the amount of current is reduced by lessening the contact pressure between A, C, and C' by an inward movement of the diaphragm, the magnet N S exerts more attractive force; for the armature adding thereby to the movement set upon the diaphragm D, by increasing the pressure by an outward movement of the diaphragm, more current flows through the helices, increasing the repulsion between the armature and the magnet N S, thus adding to the contact pressure, and thereby increasing the amplitude of the electric waves flowing through the "cymaphen" or receiving instrument.

One of Mr. Varley's receivers is illustrated in Fig. 4. It consists of a diaphragm, D, having a coil, K, of insulated wire near it. An adjustable core, N, is placed inside it. Around this coil are placed several other coils, K', the cores of which are in contact with the diaphragm D. The cores of these coils are magnetised either by permanent magnets, or by an electric current. In this arrangement the diaphragm is highly magnetised from the margin to the centre. In another form all the coils are wound with two separate wires, the primary being connected with a local battery to magnetise the whole, and the secondary being made part of the line circuit.

ELECTRIC LIGHTING OF THE VARIETY THEATRE

Since the 1st Sept. the Théatre des Variétés has been wholly lighted by electricity, Swan lamps and Faure accumulators, charged by three Siemens dynamo-electric machines, driven by an Otto 12 horse-power gas engine, being employed. There are 265 lamps in use. All the lamps, excepting those on the stage, of much smaller size, are connected up in shunt circuits, those on the stage being grouped in twenty shunts, comprising three lamps in series. To supply these lamps with current directly from machines would require a motor of 50 horse-power; the accumulators have enabled the difficulty to be got over and satisfied every requirement with the use of a 12 horse gas motor only. This motor works twenty hours a day, with two rests of two hours, one after the performance, the other during the day, about noon. The current produced is employed to charge the accumulators, arranged in seven series of 33 cells in each. Each of these accumulators weighs about 60 kilograms (about 1cwt. 20lb.) and encloses 42 kilograms (92lb. about) of active matter, reduced lead and lead oxide. The 231 cells weigh, therefore, about 14,000 kilograms (13 tons 15cwt.), and enclose 9,700 kilograms (about 19½cwt.) of lead. The whole of the system is connected up in derivation; the three machines, their inductors, the accumulators, and the lamps, are connected to two large principal conductors, which serve as a connection between the producing apparatus, the machines, the reservoirs or accumulators, and the consuming apparatus or incandescent lamps. The three machines are excited by a shunt circuit. Their power is regulated by introducing a greater or less resistance into the existing circuit. They work normally with an intensity of 23 amperes, or 70 amperes for the three machines, of which 10 are used for exciting and 60 go to charge the accumulators, dividing themselves almost equally amongst the seven series. During the performance, as the expenditure equals about 350 amperes—or more accurately 350 coulombs per second—including the exciting circuit, which consumes 10 amperes, machines and accumulators supply this current in the following proportions:—Three machines at 28 amperes, 84; seven series of accumulators at 38 amperes, 266—total, 350. It may be remarked here that during the performance the machines supply rather more current than when charging the accumulators. There are several advantages obtained by this arrangement. First of all, the electromotive force is not very high, and does not exceed 70 volts, thus eliminating all danger, and requiring but little insulation. In the second place—and this is an important point—if a machine or series of accumulators is accidentally put out of gear, the lighting is in no wise affected, the remaining machines and

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the serviceable accumulators having simply to supply a little more current to keep up the proper state of things, which is done perfectly naturally, by reason of the small internal resistance of the accumulators and machines. The supply of electric energy which they store is as large as is required, and it is only necessary to charge for sixteen hours—including the performance—to be certain of the supply. The effect produced is most satisfactory. Complaints have been made of the vividness of some of the lamps, which burn in naked globes; this is easily remedied by covering them with a ground glass globe.—*La Nature.*

AN ELECTRIC LAUNCH.

The following letter from Professor Silvanus P. Thompson appeared in *The Times* of September 29:—"Having been one of a privileged party of four, the first ever propelled upon the waters of the river Thames by the motive power of electricity, I think some details of this latest departure in the applications of electric science may be of interest. At half-past three this afternoon (September 28) I found myself on board the little vessel 'Electricity,' lying at her mooring off the wharf of the works of the Electrical Power Storage Company at Millwall. Save for the absence of steam and steam machinery the little craft would have been appropriately called a steam launch. She is 26ft. in length and about 5ft. in the beam, drawing about 2ft. of water, and fitted with a 22in. propeller screw. On board were stowed away under the flooring and seats, fore and aft, forty-five mysterious boxes, each a cube of about 10in. in dimensions. These boxes were nothing else than electric accumulators of the latest type as devised by Messrs. Sellon and Volckmar, being a modification of the well-known Planté accumulator. Fully charged with electricity by wires leading from the dynamos or generators in the works, they were calculated to supply power for six hours at the rate of 4 horse-power. These storage cells were placed in electrical connection with two Siemens dynamos of the size known as D 3, furnished with proper reversing-gear and regulators, to serve as engines to drive the screw propeller. Either or both of these motors could be 'switched' into circuit at will. In charge of the electric engines was Mr. Gustave Phillipart, jun., who has been associated with Mr. Volckmar in the fitting up of the electric launch. Mr. Volckmar himself and an engineer completed, with the writer, the quartette who made the trial trip. After a few minutes' run down the river, and a trial of the powers of the boat to go forward, slacken, or go astern at will, her head was turned Citywards, and we sped—I cannot say steamed—silently along the southern shore, running about eight knots an hour against the tide. At 37 minutes past 4 London Bridge was reached, where the head of the launch was put about, while a long line of onlookers from the parapets surveyed the strange craft that without steam or visible power—without even a visible steersman—made its way against wind and tide. Slipping down the ebb, the wharf at Millwall was gained at one minute past five, thus in 24 minutes terminating the trial trip of the 'Electricity.' For the benefit of electricians I may add that the total electromotive force of the accumulators was 96 volts, and that during the whole of the long run the current through each machine was steadily maintained at 24 amperes. Calculations show that this corresponds to an expenditure of electric energy at the rate of 3 1-11 horse-power. It is now 43 years since the Russian Jacobi first propelled a boat upon the waters of the Neva by aid of a large but primitive electro-magnetic engine, worked by galvanic batteries of the old type, wherein zinc plates were dissolved in acid. Two years ago a little model boat was shown in Paris by M. Trouvé, actuated by accumulators of the Faure-Planté type. The present is, however, not only the first electric boat that has been constructed in this country, but the very first in which the electric propulsion of a boat has been undertaken on a commercial scale. Looking at this first practical success, who shall say to what proportions this latest application may not attain in the next decade?"

EQUILIBRIUM OF LIQUID CONDUCTING MASSES CHARGED WITH ELECTRICITY.*

BY LORD RAYLEIGH.

In consequence of electrical repulsion, a charged spherical mass of liquid unacted on by other forces is in a condition of unstable equilibrium. If a_0 be the radius of the sphere, Q the charge of electricity, the original potential is given by

$$V = \frac{Q}{a_0}.$$

If, however, the mass be slightly deformed, so that the polar equation of its surface, expressed by Laplace's series, becomes

$$r = a\,(1 + F_1 + F_2 + \ldots + F_n + \ldots),$$

then

$$V = \frac{Q}{a_0}\left\{1 - \Sigma\,(n-1)\iint \frac{F_n^2\,d\sigma}{4\pi}\right\},$$

and the potential energy of the system, reckoned from the equilibrium position, is

$$P^1 = -\frac{Q^2}{8\pi a_0}\Sigma\,(n-1)\iint F_n^2\,d\sigma.$$

In actual liquids this instability, indicated by the negative value of P^1, is opposed by stability due to the capillary force. If T be the cohesive tension, the potential energy of cohesion is given by

$$P = \tfrac{1}{2}\,a_0^2\,T\,\Sigma\,(n-1)\,(n+2)\iint F^2\,d\sigma.\dagger$$

If $F_n \propto \cos\,(p\,t + \epsilon)$, we have for the motion under the operation of both sets of forces

$$p^2 = \frac{n\,(n-1)}{\rho\,a_0^3}\left\{(n+2)\,T - \frac{1}{4\pi}\,\frac{Q^2}{a_0^3}\right\}.$$

If $T > \frac{Q^2}{16\pi a_0^3}$, the spherical form is stable for all displacements. When Q is great the spherical form is unstable for all values of n below a certain limit, the maximum unstability corresponding to a great but still finite value of n. Under these circumstances the liquid is thrown out in fine jets, whose fineness, however, has a limit.

The case of a cylinder, subject to displacement in two dimensions only, may be treated in like manner.

The equation of the contour being, in Fourier's series,

$$r = a\,(1 + F_1 + \ldots + F_n + \ldots),$$

we find as the expression for the potential energy of unit length

$$P' = -\frac{Q^2}{l^2}\,\Sigma\,(n-1)\int \frac{F_n^2\,d\theta}{2\pi},$$

Q being the quantity of electricity resident on length l.

The potential energy due to capillarity is

$$P = \tfrac{1}{2}\,\pi\,a\,T\,\Sigma\,(n^2-1)\int \frac{F_n^2\,d\theta}{2\pi},$$

and for the vibration of type, n, under the operation of both sets of forces,

$$p^2 = \frac{n^2 - n}{\rho\,a^3}\left\{(n+1)\,T - \frac{2\,Q^2}{\pi\,l^2\,a}\right\}.$$

The influence of electrical charge in diminishing the stability of a cylinder for transverse disturbances may be readily illustrated by causing a jet of water from an eliptical aperture to pass along the axis of an insulated conductor tube, which is placed in connection with an electrical machine. The jet is marked with a recurrent pattern, fixed in space, whose wave-length represents the distance travelled by the water in the time of one vibration of type, $n = 2$. When the machine is worked the pattern is thrust outwards along the jet, indicating a prolongation of the time of transverse vibration. The inductor should be placed no further from the nozzle than is necessary to prevent the passage of sparks, and must be short enough to allow the issue of the jet before its resolution into drops.

* Paper read before British Association.

† See *Proceedings*, Royal Society, May 15, 1879.

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The value of T being known (81 C.-G.-S.), we may calculate what electrification is necessary to render a small raindrop of, say, 1 millimetre diameter unstable. The potential, expressed in electrostatic measure, is given by

$$V = \frac{Q}{a_0} = \sqrt{(16 \pi a_0 T)} = 20.$$

The electromotive force of a Daniell cell is about ·004, so that an electrification of about 5,000 cells would cause a division of the drop in question.

ON THE THICKNESS OF WIRE REQUIRED TO CARRY DIFFERENT ELECTRIC CURRENTS WITHOUT OVER-HEATING.*

BY PROFESSOR G. FORBES.

During the present year I have made some experiments to find the different strengths of current which could be passed through wires of different thicknesses so as to raise them to a given temperature. Two special cases have been examined (1) where we have a bare wire exposed to the air, and (2) where we have a coil of wire such as that used on an electro-magnet, or on the armature of a dynamo-machine.

(1). When a steady current is passing through a bare wire, so that the temperature is constant, the heat generated in a given length of the wire by the current is equal to that which is taken from the wire by radiation and convection. It seems right to suppose that, at a fixed temperature, the latter is proportional to the area exposed, that is, to the diameter of the wire. The former (by Joule's law) is proportional to C^2 R, or to $\frac{C^3}{D^2}$, where C is the current strength, R is the resistance, and D the diameter of the wire. Thus, we find that

$$\frac{C^2}{D^2} = a\,D,$$

where a is a constant; or

$$C = a\,D^{\frac{3}{2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

To test the accuracy of this law three wires of different diameters, of the same specific conductivity, were chosen, and a small quantity of beeswax (melting temperature 136° Fahr., the temperature of the air being 65° Fahr.) was melted on to each. A current was passed through one of the wires, and by taking out small resistances at considerable intervals of time (to allow the wire to become heated) a strength of current was at last reached just sufficient to melt the beeswax. The tangent of the angle of deflection of a tangent galvanometer was then noted, giving the value of the current strength. The same operation was then followed with the other wires. The following table shows the results. If $C = a\,D^{\frac{3}{2}}$, then the quotient $\frac{C}{D^{\frac{3}{2}}}$ should be constant for all wires. If (as some people have assumed) $C = a\,D^2$, then the quotient $\frac{C}{D^2}$ should be constant. If the law were $C = a\,D$, then the quotient $\frac{C}{D}$ should be constant. The values of these quotients are also given:—

D	C	$\frac{C}{D}$	$\frac{C}{D^{\frac{3}{2}}}$	$\frac{C}{D^2}$
mm.				
0·58	·984	1·696	2·229	2·924
1·22	2·304	1·888	1·709	1·548
1·58	3·026	1·915	1·523	1·212

The experiments show decidedly that the current strength does not vary as the sectional area, and that it varies more nearly in proportion to the diameter than in proportion to the diameter raised to the power $\frac{3}{2}$. I am continuing the experiments with greater difference of thickness of wires, and shall publish the results before long.

(2). If we have two bobbins of equal size but wound with wires of different thickness, until they have the same size and weight, and if there be a considerable number of turns of wire on each bobbin, then the length of wire is proportional to $\frac{1}{D^2}$, and the resistance of a given length of the wire is proportional to $\frac{1}{D^2}$. Hence, the total resistance of the coil is proportional to $\frac{1}{D^4}$, and the heat generated in the coil in a unit of time is proportional to C^1 R or $\frac{C^1}{D^4}$. But the surface of the coils is equal. Hence, when we have the same temperature in the two bobbins, the heat lost by radiation and convection in a given time is constant. And if a uniform temperature is attained, the heat lost must be equal to the heat generated. Hence we have:—

$$\frac{C^1}{D^4} = a,$$

where a is a constant; or

$$C = a\,D^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

To test the accuracy of this law two brass tubes with flanges at each end were prepared, each tube being closed at one end; wires of different thicknesses were wound upon each until their weights were equal. One of them was filled with water, in which a thermometer was placed, and the current very slowly increased until a permanent and sufficiently high temperature was attained. The current strength was then noted by the tangent galvanometer. The operation was repeated with the other bobbin, the same temperature being attained. It was always found that the current strength required to raise a bobbin to a definite temperature divided by the square of the diameter of wire with which the bobbin was wound was constant, thus proving the truth of the theoretical law given by the formula (2).

ON A NEW ARC LAMP.*

BY PROFESSOR G. FORBES.

This arc lamp was designed specially as a lighthouse lamp, with the light fixed at one point, and suitable for currents of great quantity. The carbons are supported on racks, which are worked by two pinions, one being double the diameter of the other. These pinions are both on the same axis, together with a third and large-sized toothed wheel. All these are insulated from each other. In this toothed wheel a wormscrew acts, and by its rotation in one direction or the other causes the carbons to approach or recede. This toothed wheel can be released from the two pinions by means of a nut on the axis, so that the carbons can be rapidly separated or brought together. The other end of the worm screw forms the axis of a Gramme ring, wound with one layer of insulated No. 10 wire, and the outer surface of the wire is laid bare, so as to act as a Gramme commutator, contact being made with two brass rollers instead of brushes. The ring is fed by these rollers by a shunt on one of the wires leading to the lamp. The Gramme ring is surrounded by two field magnets, one of which is on the main circuit, and, when acting on the Gramme ring, tends to separate the carbons; the other field magnet is on a shunt on the arc, and made with very thin wire, and when acting on the Gramme ring tends to make the carbons approach.

On sending a current through the lamp, the carbons are at first in contact. The field magnet through which the main current passes then acts on the ring (through whose coils a powerful current is always passing) and separates the carbons so as to strike the arc. If the arc becomes too long the shunt field-magnet becomes the most powerful, and acting on the ring causes the carbons to approach. If the cur-

* Paper read at the British Association.

* Paper read at the British Association.

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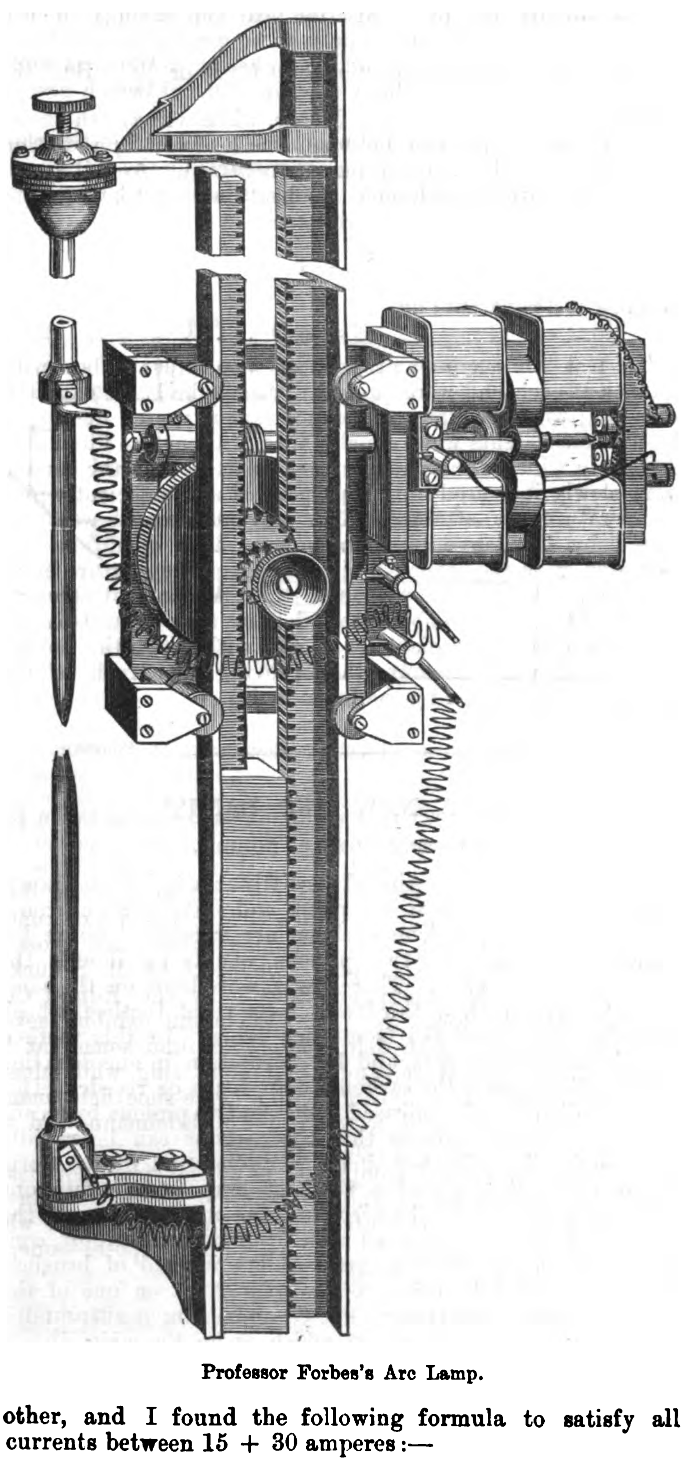
rent happens to increase in intensity the resistance of the arc immediately diminishes, and the field magnet on the arc circuit becomes more powerful and separates the carbons. This is essential in a lighthouse lamp to prevent flickering and sputtering, but the variable resistance of the arc has hitherto received far too little attention. I have had experiments made on an arc of fixed length (4 mm.), and with carbons 13 mm. diameter. By varying the strength of current and measuring the resistance, I found that the charge in the one was proportional to the charge in the



Professor Forbes's Arc Lamp.

other, and I found the following formula to satisfy all currents between 15 + 30 amperes:—

$$R = 0{\cdot}7 + (30 - C) \times 0{\cdot}93,$$

where R is the resistance of the arc in ohms and C is the current in amperes.

The support of this lamp may receive a slight movement up or down to counteract the effect of an irregular consumption of the carbons. The body of the lamp is not in the circuit, so that a shock cannot be got by handling it. The lamp is not patented.

THE MUNICH EXHIBITION.

At the commencement of the autumn of 1881 we often heard the exclamation that during the next six months "electricity would be on its trial," and now at the commencement of the autumn of 1882 the same phrase is heard on every hand. There is just as much truth in the saying as in ninety-nine of the ever recurring popular watchwords. To a certain extent electricity is on its trial, in so far as its application to electric lighting is concerned, but even in this direction we may safely say that the critical period is past, and neither local boards nor national parliaments can stop its progress. Its advancement is as certain as was that of the steam engine in the time of Stephenson. Even if we did not recognise this from a scientific point of view, it would not be difficult to obtain an insight into the immediate future by the application of a little common sense. France, or rather Paris, laid the foundation stone, she really brought conviction to many minds as to the possibilities of an electrical age, and every large town seems inclined to build upon the foundation. Exhibitions electrical are the order of the day, and every succeeding exhibition proves to be of greater importance than appeared at first sight.

There was a time when builders of portable and other steam engines, for example, threw all their energies into the production of competitive engines for trial by the Royal Agricultural Society, and the periodic recurrence of such trials, together with the advertisement thus obtained, did more towards the perfection of such engines than anything we can remember. If we are not mistaken, something of like nature is being carried out under the auspices of these various exhibitions so far as regards certain electrical apparatus. The manufacturers themselves do not always recognise this fact or think it unnecessary to continue to succeed, otherwise we surely should have found more care taken by some of the exhibitors at Munich, where the tests will, perhaps, be more complete, exhaustive, and unbiassed than has hitherto been the case.

It was intended at the commencement of the year that an exhibition should be held in Vienna, but the arrangements at Munich were in a forward state, and it was found that exhibitors did not care to send exhibits to both exhibitions at the same time. The Vienna Exhibition was postponed for a year in favour of that at Munich. The Crystal Palace at Sydenham seems to have been copied more or less faithfully, and on a smaller scale, in several continental towns, and it is in a large building of this description, known as the Glass Palace, that the exhibition at Munich is being held.

We herewith give a ground plan of the building, with reference numbers to the principal exhibits. Part of the space is occupied with a small exhibition of an agricultural character, the reason of this being that the Agricultural Society had prior rights, and it was only by some such arrangement for both exhibitions to run together that the building could be obtained.

Our references will be far more general than special in this first article, but in future numbers we hope to describe some of the exhibits pretty fully. The exhibition is not of very large proportions, nor is there any apparatus of great novelty. The important fact gleaned by a description of the exhibits is that progress is continuous, and that ideas which theoretically show signs of promise are sure of a practical trial sooner or later.

The lighting of interiors by means of arc lamps has three exponents, M. Schuckert lighting the body of the small theatre by six lights through a glass screen, whilst Mr. Crompton lights the interior of a small model chapel by means of one arc lamp. A dining room, also, is lighted by two Siemens lamps outside stained glass windows. The stage of the theatre is lighted by means of Edison incandescent lamps, as are two rooms at one end of the building, and a large portion of the restaurant. A picture gallery is lighted from above by means of arc lamps. For some time, however, the lighting was imperfect, but gradually the arrangements were perfected, and the lighting is a complete success. Swan, Maxim, Müller, and other incandescent lamps are used to light specially-arranged rooms. A central

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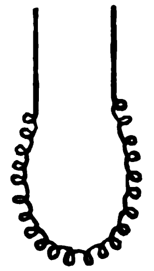
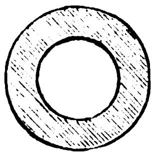
fountain with side jets plays in the main transept, the rays from two lamps being sent through coloured lenses and so to the water, giving a very pretty effect.



Müller's Carbon.



Cruto's Carbon.

The tests of the incandescent lamps of Müller and Cruto will be looked forward to with a considerable amount of interest. The carbon filament of the former differs from that in better known lamps only in its being made, as shown in the accompanying figure, in a spiral form. The Cruto lamp possesses theoretic and practical interest. The filament is hollow. The carbon is deposited electrolytically, and is shaped externally somewhat like the Müller carbon. The figure shows a section of the carbon. Taking the heat of the carbon as represented in the equation,

$$H = C^2 R,$$

we know R depends on sectional area, and we see that, by making the carbon hollow, the same length with the same external diameter of carbon will have a greater resistance. Thus, we get at pleasure the same radiating surface at a higher temperature with a constant current, or at the same temperature with a smaller current. We see from the formula that doubling the resistance means, with the same current, increasing H proportionally, or with H constant, reducing the **current. Suppose, for instance, C = 1 and R = 30, then H is represented by**

$$C^2 R = 1^2 \times 30 = 30,$$

doubling R we get

$$1^2 \times 60 = 60,$$

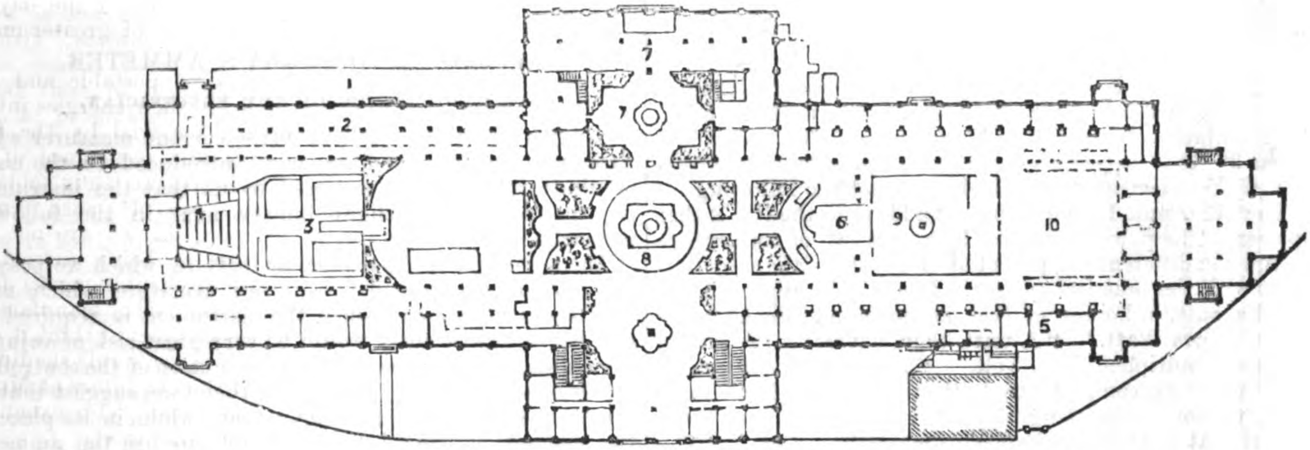
or if we prefer to reduce C we get

$$C^2 R = 30,$$
$$C^2\, 60 = 30,$$
$$C^2 = \tfrac{1}{2},$$
$$C \quad \sqrt{\tfrac{1}{2}}.$$

A feature of this exhibition are the fittings for incandescent lights. A small sum is to be given in prizes for the three best chandeliers, and a number of designs, as well as finished articles, have been sent in, some of which are very good.

We notice that paragraphs are being inserted in the papers to the effect that interesting experiments on the transmission of power over considerable distances are being carried out. At the time of our writing such transmission has taken place across the building only, and not from the water power at a distance. What is actually being done and what it is proposed to do are two different things, but we have no doubt that before the exhibition closes the proposed experiments will be carried out. The dynamos shown are those of Bürgin by Messrs. Crompton, Schuckert by M. Schuckert, Siemens by M. Rudinger, Edison by the Edison Company, Brush, Fein, &c. Dr. Edelmann exhibits several small dynamos, with field magnets wound somewhat like the Bürgin armature, and a Gramme ring, while Messrs. Einstein exhibits a dynamo with a horse-shoe field magnet wound like the field magnet of Dr. Edelmann, and also having a Gramme ring armature.

We heard several complaints as to the steam power supplied to the exhibitors, and failures and fluctuations in the lights were often attributed to the engines, some of which were clearly not adapted to electric light purposes—one, for instance, having no governor.



GROUND PLAN MUNICH EXHIBITION.

1. Steam Engines. 2. Dynamos. 3. Theatre. 4. Stage of Theatre. 5. Edison Exhibits. 6. Chapel. 7. Restaurant. 8. Fountain. 9. Picture Gallery. 10. Railway Apparatus.

Electric Light in a Flour Mill.—A permanent installation of incandescent lamps has recently been completed at Messrs. Bowyer and Priestley's Flour Mill, Buckden, near Huntingdon. The current is generated by a Siemens continuous current dynamo, capable of maintaining sixty incandescent lamps, a number of which are destributed in all parts of the mill, passages, engine, and boiler house. As the mill runs all night the steady, brilliant, and colourless light is found very advantageous, enabling the attendants of the various machines to examine the quality of the flour as by day-light. The work was carried out by Messrs. Charles Powis and Co., engineers, 60, Gracechurch-street, E.C., and we understand the light is giving great satisfaction.

Conversazione at Mason College, Birmingham.—A *conversazione*, organised by the professors and lecturers of this college, took place on Monday last. The main staircase and the physical laboratory were lighted by Messrs. R. W. Winfield and Co., of Birmingham, by means of Swan lamps; whilst the National Telephone Company connected some of the rooms by telephone, so that visitors could try the instruments for themselves. Numerous electric lamps, measuring apparatus, and models, showing the various practical applications of electricity that have cropped up of recent years were shown, whilst in the physical laboratory and tool shops all manner of machines could be seen. Altogether the *conversazione* was a success.

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CORRESPONDENCE.

BRITISH ASSOCIATION UNITS: AN OLD FRIEND IN NEW COMPANY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the first volume of *The Electrician*, p. 236, under date October 5, 1878, you were good enough to publish a letter signed by myself, from which I make the following extracts:—

"Below is a table of electrical units, as used in my class for several years past." "No. 7 is the British Association unit of work, which I have constantly had occasion to use, and which I have ventured to name after the distinguished physicist, Dr. Joule." "*Practical units of measurement in metre-Gramme-second absolute units:*—* * * 7. Work (or mechanical equivalent of heat evolved + work done)— $W = \text{joulad} = \text{veber} \times \text{volt} = 10^{-2} \times 10^5 = 10^3$ M.-G.-S. units.*

"The absolute M.-G.-S. unit of work being $\frac{1}{9\cdot811}$ gram-metres, the joulad = 101·926 gram-metres = ·7352 foot-pound, = ·00093 calories English = ·24 calories French."

In the ninth volume of *The Electrician*, p. 342, under date August 26, 1882, appears a report of the presidential address of Dr. C. W. Siemens, from which I extract the following:—

"The other unit I should suggest adding to the list is that of power. The power conveyed by a current of an ampere through the difference of potential of a volt is the unit consistent with the practical system. It might be appropriately termed a watt, in honour of that master mind in mechanical science, James Watt." "A watt, then, expresses the rate of an ampere multiplied by a volt." "Before the list can be looked upon as complete, two other units may have to be added, the one expressing that of magnetic field and the other of heat in terms of the electro-magnetic system." "The unit of heat has hitherto been taken variously as the heat required to raise a pound of water at the freezing-point through 1deg. Fahrenheit or Centigrade; or, again, the heat necessary to raise a kilogramme of water 1deg. Centigrade. The inconvenience of a unit so entirely arbitrary is sufficiently apparent to justify the introduction of one based on the electro-magnetic system, viz., the heat generated in one second by the current of an ampere flowing through the resistance of an ohm. In absolute measure its value is 10^7 C.-G.-S. units." "Such a heat unit, if found acceptable, might with great propriety, I think, be called the joule, after the man who has done so much to develop the dynamical theory of heat."

In the presidential address nothing was said of any unit of work (or of work + heat), although the unit of power, necessarily involving that of work, was specified as above. But in a paper, subsequent to the address, read by Dr. Siemens before Section A of the association, the joule is used and specified as the unit of work as well as that of heat. Thus it is stated that "Accepting the joule, the watt can be briefly defined as a joule per second;" and in the list of units we have:—

"6. Joule, unit of heat or work = 10^7 C.-G.-S. units."

It will be seen that the *joule* is simply our old friend the *joulad*, of a submultiple of which Professor Lodge once said:—"Mr. FitzGerald must pardon me if I decline to follow him into such fearful things as *microjoulads*, because I really do not know what they are."†

But the most funny thing is that, at the British Association meeting, nobody apparently thought it worth his while to inform the members of Section A that they were a little behindhand with this unit of work and heat, if not in some other matters electrical. Of course, I am quite sure that if Dr. Siemens had known or remembered that his unit of work and heat had been suggested, used, and published years ago, he would, *en passant*, have mentioned the fact. And, of course, if I had, years ago, "gone in for" the cultivation of a "reputation," and duly joined a Mutual Admiration and Great-Gun Adulation Association (unlimited), I should have had my name mentioned "all over the place." Not that my ambition lies in that direction; what I mean to convey is—well, that science is becoming quite an art!

I suppose no one imagines that the list of British Association units will long remain without further alterations. The history of these units—one of which has changed its name so often that it might well be called "the widow"—illustrates a sublime docility on the part of the electrical public, and press, which must be subjected to further trials. My own view is that the unit of capacity must give way to a unit of electrostatic resistance, which is the analogue of the ohm, and has the same value. Or, if it be preferred, the unit of conductive resistance must give way to a unit of conductivity, or conductive capacity, which is the analogue of the farad. I hold, moreover, that the ampere and watt are superfluous and useless units, being already expressed by the coulomb and joule.—Yours, &c., DESMOND G. FITZGERALD.

* Since the Erg. = 10^{-4} of the M.-G.-S. unit of work, the joulad would, of course, be 10^7 centimetre-gram.-second units of work.

† *The Electrician*, April 26, 1879, p. 273.

AYRTON AND PERRY'S AMMETER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In using the excellent little current measurer which Professors Ayrton and Perry have introduced to the notice of electricians, it has occurred to us that the instrument is capable of some slight improvement in the following respect.

The ammeter, of the particular pattern which we possess, has its magnet provided with an armature which must necessarily be removed when the instrument is required for use, for otherwise there would be very great risk of injuring the delicate needle, owing to the diminution of the controlling power of the magnet. We would, therefore, suggest that the armature should be so contrived that, while in its place on the magnet, it should be impossible to use the ammeter. In the case of those instruments packed in wooden boxes the armature might, perhaps, be attached to the lid in such a way that the mere act of opening the box should suffice to remove it. Where no box is provided, perhaps a light shield might be so fixed to the armature that when in position the graduated portion of the dial should be hidden.

But other methods of carrying this idea into effect will probably occur to Professors Ayrton and Perry, should they think our suggestion worth adopting.—Yours, &c.,

2nd October, 1882. I. PROBERT.
ALFRED W. SOWARD.

COSMICAL INDUCTION.—In a recent communication to the French Academy of Science, M. Quet discusses the forces of induction produced by the sun in the planets and due to the velocity or revolution of these bodies. From time to time M. Quet has developed his theory of the inductive action of the sun upon the earth as a planet, and attempted to explain the diurnal period of compass needles, their hourly inequality, which completes itself in twelve months, their annual variation and period of twenty-six days. It is significantly in favour of his theory that the apparent period of revolution of the sun round its own axis is also twenty-six days; and the fact seems to indicate that the sun has a magnetic axis turning with him which acts inductively on the magnetism of the earth. Accepting this as true, M. Quet extends the observation to other planets, and assumes that there is likewise a magnetic induction between the other planetary bodies. The sun ought also to induce magnetic and electric changes in the other planets, in comets, and other cosmical bodies; magnetic planets must also induce changes on other distant bodies. These changes take place by the relative motions of the planets with respect to each other and the sun, and by the magnetic and electric disturbances produced in the sun by its incandescent state. The general conclusion arrived at by M. Quet is that the squares of the forces of induction produced by the sun in the planets, and due to the velocity of revolution of these bodies, are, all other things being equal, in the inverse ratio of the seventh power of the distances to the planet or other star.

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ON A SIMILARITY BETWEEN MAGNETICAL AND METEOROLOGICAL WEATHER.*

By Balfour Stewart, F.R.S.; Professor of Physics at Owens College, Manchester.

It has been hitherto supposed that there is no traceable likeness between the magnetical and meteorological changes of the globe. The former have been imagined to be of a cosmical nature affecting all parts of the earth at the same moment of time, while the latter are well known to be of a local and progressive nature. As a matter of fact, all attempts to trace a likeness between simultaneous magnetical and meteorological phenomena have been without success.

There is, however, one class of magnetical phenomena that are of a progressive nature. I allude to the diurnal variations of the magnetic elements caused by the sun. Of these the solar-diurnal variation of the magnetic declination—that is to say the variation of the position of a freely suspended magnetic needle—is that which has been most observed and best understood.

It has been noticed that the diurnal progress of this variation is not unlike that of atmospheric temperature; the hourly turning points in both being pretty nearly the same. Both phenomena, too, are regulated by the local time at the place of observation, and hence are of a progressive nature, travelling with the sun in his apparent course from east to west. Both phenomena, too, are subject to a well-marked annual fluctuation, the diurnal temperature range, for instance, or the difference between the indications of the maximum and the minimum thermometers being greater in summer than in winter; and in like manner the diurnal declination range or the difference between the east and the west positions of a suspended magnet being greater in summer than in winter. Finally both phenomena appear to be subject to the influence of something which may be called *weather*. Sometimes we have very hot days and cold dry nights in which the diurnal temperature range is very great, succeeded by close rainy weather in which the diurnal temperature oscillation is very small. In like manner we have sometimes a very large and at other times a comparatively small diurnal oscillation of the magnetic needle, so that it, too, is affected by the influence of magnetic weather. The question which I now wish to put is the following: Is there any connection between these two weathers? between the temperature-range weather and between declination-range weather, both defined as above? Now, there is, I think, preliminary evidence to show that both kinds of weather are due very greatly, if not altogether, to changes in the sun, a large declination range, and a large temperature range, denoting an increase of solar power. There is also evidence that temperature-range weather, once produced, travels from west to east, taking probably on an average eight or nine days to cross the Atlantic. There is also, I think, preliminary evidence that declination-range weather travels likewise from west to east, but quicker than temperature-range weather, taking about two days to cross the Atlantic. Now, if this be true, it might be expected that the declination-range weather of to-day should be found similar to the temperature-range weather six or seven days afterwards, so that by a study of the declination-range weather of to-day we should be able with a certain measure of success to predict the temperature-range weather six or seven days afterwards. I have here given the train of thought which led to this investigation, but I ought to say that the results obtained do not depend upon the exact truth of every step of this train of reasoning. This is in reality a matter-of-fact investigation undertaken with the view of ascertaining whether or not there is any recognisable connection between these two weathers in Great Britain. The result obtained, I may add, was reported to the Solar Physics Committee, and by them communicated to the Royal Society. In order to avoid, as much as possible, the influence of locality, I obtained, through the kindness of the Meteorological Council, the diurnal temperature-ranges at Stonyhurst, Kew, and Falmouth, for the years 1871 and 1872. I obtained, likewise, through the kindness of the Kew Committee, the diurnal ranges of magnetic declination at the Kew Observatory for the same two years, excluding disturbed observations. The temperature ranges discussed are, therefore, the means of those at the three observatories above mentioned, and still further to tone down, or equalise, individual fluctuations, the daily numbers exhibited are each the sum of four daily ranges, the two before and the two after. Finally, the object being to represent fluctuations of range rather than their absolute values, a daily series representing the mean of twenty-five daily numbers has been obtained. Each daily number is thus compared with the mean of twenty-five daily numbers, both columns being symmetrically placed with regard to time, and the differences, whether positive or negative, between the two columns is taken to represent temperature-range fluctuations. A precisely similar course has been taken with respect to the Kew declination ranges. By this means two years of daily numbers, sometimes positive and sometimes negative, representing temperature-range weather, and two years of daily numbers, sometimes positive and sometimes negative, representing declination-range weather, have been obtained. The next object is to compare the two series with one another. Now, when two series of waves, representing elevations and depressions, come together, it is well known that we shall have the greatest result when the crests of the one series coincide with the crests of the other, and the smallest result, perhaps even none at all, when the crests of the one series coincide with the hollows of the other. This, indeed, is the well-known explanation of musical beats. Now, if there be any marked likeness between the two weathers, and if it be true that declination-range weather precedes temperature weather by six or seven days, the algebraic sum of the two sets of fluctuations representing these weathers will be greatest when the declination is pushed forward in point of time so that the declination fluctuations of to-day shall be summed up with the temperature fluctuation six or seven days after.

For, suppose that the declination fluctuation of to-day is represented by a very large positive number, if the above theory be true the temperature fluctuation six or seven days afterwards will be represented by a large positive number also, so that we shall have the addition of two large positive numbers, whereas if we add the declination weather of to-day to the temperature weather of to-day it may chance that we are really adding a large positive to a large negative quantity, in which case the result will be very small. It may also happen that this amount of precedence of declination-weather is greater at one season of the year than at another. We have, therefore, to pursue a plan somewhat of the following nature:—Take a month's temperature-weather, say for the month of August, and add to it a month's declination-weather, extending say, from July 21 to August 21. Let the sum be 262. Here the declination month has been pushed forward 11 days. Next push it forward 12 days, and let the sum be 273; then 13 days, and let the sum be 276; next 14 days, and let the sum be 270. It thus appears that the greatest sum is got by pushing the declination forward 13 days, and we may, therefore, presume that at this season of the year 13 days denotes the precedence of the declination-weather. On this principle the following table has been constructed. Table showing by how many days the declination-range fluctuation precedes the corresponding temperature-range fluctuation:—

Corresponding to middle of Month.	Precedence of Declination. 1st Year.	2nd Year.	Mean.
January	—	8	8
February	6	4	5
March	6	5	5·5
April	5	5	5
May	9	9	9
June	9	9	9
July	12	11	11·5
August	13	13	13
September	9	10	9·5
October	7	5	6
November	10	7	8·5
December	12	—	12

It thus appears from each year that the precedence of

* Paper read at Southampton meeting of British Association.

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declination is smallest about the equinoxes, and greatest about the solstices, and it seems probable that were a considerable number of years so treated, more exact values would be obtained. Having thus determined the amount of precedence of the declination from month to month, the next point is to ascertain to what extent the two fluctuations when brought together in a manner regulated by this precedence show any distinct resemblance to each other. This has been done in a graphical representation which accompanies the report above mentioned, and I think I may say that there is a considerable likeness between the two curves, the one exhibiting temperature-range weather and the other declination-range weather so pushed forward. It would thus seem as if a comparison of magnetical and meteorological weather might be made a promising subject of inquiry, besides being one which may perhaps lead to results of practical importance.

BIRMINGHAM AND WARWICKSHIRE (BRUSH) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of this company was held at 110, Cannon-street, on the 29th ult., to consider the following resolution passed at the meeting held on the 15th ult.:—"That the Articles of Association of the Company be altered in manner following, viz.:—That Clause 40 thereof be cancelled. That from Clause 41 thereof the words following shall be omitted, viz., 'Or the person entitled to the share by transmission, as the case may be.' That from Clause 112 thereof the words following shall be omitted, viz., 'Or otherwise interested.'" Mr. George M. Felton, C.C., presided.

The CHAIRMAN stated that the only business before the meeting was to consider the resolution passed at the present meeting. If passed, they hoped to put themselves in a position to get a settlement on the Stock Exchange. In reply to questions, he added that several matters were in negotiation, and the manager would have pleasure in showing the communications to any shareholder on applying at the offices. The contract to which he referred at the last meeting, with a firm having large works in Birmingham (whose solicitor at the time was absent), had since been settled. They had an extension of time in which to commence operations to November, when they hoped to begin. He thought they had every prospect of a good business, but he would rather that the shareholders should see the matters they had in negotiation with various firms and corporations for the use of the light. There was nothing now to interfere with their going on. The only delay was in their making the best bargains they could. Sometimes applicants thought they should do the business by way of advertisement, but they had found the applications in their district so large that they had come to the conclusion that the bargains must be made for the advantage of the Company. They did not intend to do any business at a loss. At the last meeting they had £10,000 invested at 3 per cent., now it was at 3½ per cent. at their bankers, and it would pay them better to let it remain there than do their business at a loss.

Mr. HITCHENS seconded the resolution, which was carried unanimously, and the meeting then separated.

JABLOCHKOFF ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

An extraordinary general meeting of the shareholders in this Company was held on the 3rd inst. at the City Terminus Hotel, under the presidency of Mr. James Wilson, to consider the resolution passed at the meeting on the 15th ult.

The CHAIRMAN stated that the only business was to submit for confirmation the special resolution passed at the last meeting. He should be happy to give any explanation concerning the resolution, but the matter was fully entered into at the last meeting [the object of the proposed alterations being to comply with the request of the committee of the Stock Exchange previously to their granting a settlement]. He moved the confirmation of the resolution, which was for altering the Articles of Association by omitting Articles 16, 20, and 31; the words "and the dividends (if any) forfeited therewith" from Article 32, and the word "meeting" between the words "such" and "to" in Article 48, and the insertion instead thereof of the words "business shall be given."

Mr. TOOLEY (shareholder) seconded the motion, and it was carried unanimously.

The meeting then separated.

EASTERN EXTENSION TELEGRAPH COMPANY.—The Eastern Extension, Australasia, and China Telegraph Company notify that their accounts for the half year ended 30th June last show, subject to audit, a net profit of £113,393, against £94,755 for the corresponding period 1881. After providing for two quarterly interim dividends, and a bonus of 1s. per share, making together 3 per cent. for the half year, and charging against the half-year's revenue £30,000, the balance of cost of the Singapore-Batavia cable, there remains £23,468 to be carried forward.

SWAN UNITED ELECTRIC LIGHT COMPANY.—This company have removed from 41, Coleman-street, E.C., to 9, St. Mildred's-court, Poultry, E.C.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).

The eighteenth ordinary general meeting of this Company was held on the 29th ult., at the City Terminus Hotel, under the presidency of Mr. Neil Bannatyne.

The MANAGER (Mr. Charles Gerhardi) having read the notice convening the meeting, the report was taken as read.

The CHAIRMAN: Gentlemen, the report and accounts are in your hands, and I have no doubt you have given them careful perusal. I think there is nothing in the report or accounts that requires any special remark from me before I propose the first resolution. The shareholders, I think, will have looked at the accounts, as the directors have done, with perhaps somewhat mixed feelings. As regards the increase of the traffic, we look upon that with great satisfaction. It has been considerable, and steadily maintained from month to month throughout the half year, with the exception of the month of May, during the greater portion of which the Bilbao cable was interrupted. While we look at the increase of traffic with great satisfaction our satisfaction is somewhat modified by the circumstance that we do not get the results which we should otherwise have anticipated from the increase of the traffic in consequence of our having had to repair the Bilbao cable, the cost of which, as you see from the accounts, has been no less a sum than £2,814 9s. 4d.; and although that amount is not in excess of what we anticipated—nor do we think it can be considered an unreasonable amount, having regard to all that has had to be done—it has very materially reduced the balance of profit and loss which otherwise would have been at our credit, and which we should have had to dispose of to-day. You can easily see that if we had had no interruption during the last six months we should have been able to pay you—the ordinary shareholders—a much higher dividend than we are declaring to-day. We should have been able to add more to the reserve fund than we recommend to-day, and we should have carried forward a larger balance than remains. Still, I must say for myself—and I suppose my colleagues agree with me—we consider we are in a more satisfactory position now than we have ever been in. We have a reserve fund of £6,000, we have a steady increase of traffic over what we ever received before, and our prospects are altogether better, I think, than they have been when we have met you on any former occasion. I trust we shall have no interruption in either of our cables for some time to come, and, if so, we shall no doubt be in a position to pay the ordinary shareholders a considerably higher rate of dividend than now, and at the same time add most materially every six months to our reserve fund, which we all consider a matter of the highest importance to the welfare of the Company. I may just say that for the three months which will expire to-morrow of the present half year our receipts will show an increase of something like £680. We can scarcely expect to maintain that increase for the rest of the half year, because the receipts for the corresponding period last year were considered good, but if we have no increase—if we merely maintain our receipts for the next three months, we shall be in a better position than we have ever been in yet. That is, of course, contingent on the cables working the whole time. I may also mention, for your information, that the fault in the Bilbao cable was in about ninety fathoms of water, near the French coast. The cable on both sides the fault was found in exceedingly good condition—as sound as when laid. In looking at the expenses I may remark that, although there is an unavoidable increase in consequence of the increased traffic, the proportion of expenditure is not higher than hitherto, and, as compared with the receipts, will contrast very favourably with that of other companies doing the same description of traffic. The board will continue to give their efforts to keep down the expenditure as far as is consistent with the proper working of the lines. We are making arrangements to have a special wire between London and Falmouth. This will really involve little or no increase of expenditure, as the rental of the wire and the pneumatic tube will amount to rather less than the sum we now pay to the Post Office for transmitting our messages between these points, and we are certain to derive advantage from the arrangement. As regards the payment of the dividend, I may say that we have received a telegram from Madrid, stating that the balance of the messages account for the second quarter of the present year may be expected to be received—at all events, the greater portion of it—by about the 15th or 20th October. The moment it is received the dividend warrants will be issued. I really do not think I have anything else to mention; but if any shareholder has any question to ask I shall be happy to reply. I now move "That the Report and Accounts be received and adopted."

Mr. ABRAHAM SCOTT seconded the motion, which was carried unanimously.

The CHAIRMAN: The second resolution is: "That the preference dividend, at the rate of 10 per cent. per annum, less income-tax, and a dividend of 3s. per share on the ordinary shares, free of income-tax, for the half year ended 30th June last, be and are hereby declared."

Mr. EDMUND ETLINGER seconded the motion, and it was carried unanimously.

The CHAIRMAN: I do not know whether the shareholders are aware of it, but I may mention that we are going to leave our present offices, and remove to much better offices, altogether superior to those at present occupied by us. We have no doubt, when once we get there, that the change will contribute to the increase of our business. The offices will be far handier for the greater number of our customers, and altogether we consider it will be a decided advantage to the Company, and will result in some increase of business. The new offices are at the corner of Leadenhall-street and Gracechurch-street, and we consider ourselves fortunate in getting such a good position.

Mr. STIMPSON desired to make a few remarks as to the ordinary shareholders. Theirs was undoubtedly growing into a very successful business, but they must remember that, while the interests of the ordinary and preference shareholders were certainly identical in the general success of the Company, they were not quite identical in the division of the money. The ordinary shareholders went for several years without getting any interest at all, and now that the takings were large and the profits proportionately good they thought that by this time they should be receiving 5 per cent. There was no doubt of the wisdom of making a good reserve fund, but he thought it not unreasonable on the part of the ordinary shareholders to hope that that fund would not be so largely increased as to place the preference shareholders, who were getting 10 per cent. out of the Company, in such a position that their shares would be equal to Government securities

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or Consols. Of course, if the reserve fund were increased to a very heavy amount, the preference shareholders would stand in a very fine position, but somewhat at the expense of the ordinary shareholders.

The CHAIRMAN: Can you point out any way in which we could place the ordinary shareholders in a more satisfactory position? The same difficulty has occurred to us.

Mr. STIMPSON replied that he would rather leave the matter to the directors. He had never been a preference shareholder.

The CHAIRMAN: Can you point out a practical way in which we can help the ordinary shareholders? We cannot help the fact of the existence of the 10 per cent. preference shares, and we were very glad to get the money at that rate when those shares were issued. Any ordinary shareholder, too, might have taken his proportion of the preference shares. We have to consider the interests of all the shareholders, and it is as much to the interest of the ordinary shareholders as it is to the interest of the preference shareholders that we should have a large reserve fund. If we gave you a larger dividend than we thought it prudent to declare, and the cables broke after we had reduced our reserve fund, or declined to add anything further to it, and we could not repair the cables for the amount of the reserve fund, the dividend on the ordinary shares would disappear altogether, and it is very doubtful when it would reappear. One practical proof of the importance of having a reserve fund is this: When our cables broke last time, in consequence of our having a reserve fund of £5,000, and the knowledge of the public and of the shareholders that that was more than sufficient to pay for the repairs, our shares only went down 10s. or 15s., while some years ago, when we had no reserve fund, the shares went down to 30s., and no one would have them. The circumstance of our having a good reserve fund, out of which we shall be able to pay any probable expense of repairing breaks, gives the ordinary shares a price in the market which they would not otherwise have, and people are content to pay that price, and have a moderate dividend till the company is in a position to pay a higher one. Although, of course, the ordinary dividend at present is a very poor return upon the amount of money paid up on the shares a great many people hold shares that were bought at and under £3, and as far as they are concerned they have a very handsome return, even with this 3s. per share. Still, we do not look at 3s. a share as the dividend that is likely normally to be paid. We expect if we are fairly fortunate as to the maintenance of the cables to pay a very much larger dividend by and by. We cannot, however, alter the position of the ordinary and preference shareholders. If you will suggest a plan by which we can get rid of the preference shares we shall be very glad to do so, but no preference shareholder will give up his rights, and most of the preference shareholders, too, are ordinary shareholders.

Mr. STIMPSON stated that he had no intention whatever to reflect on the manner in which the arrangement had always been carried out by the board. His main desire was to express a hope that the reserve fund would not be made a very large amount at the expense of the ordinary shareholders, so that the preference shareholders would get their dividends as safe as if they held consols, while the ordinary shareholders were being a little bit starved.

The CHAIRMAN: I cannot say more than I have on the point. We are not the only Company in which the same state of the share capital exists. The Cuba Company under very similar circumstances issued Ten per Cent. Preference Shares, and it has been mooted over and over again there how we can get rid of those preference shares. Nothing practical, however, has ever resulted from those discussions.

Mr. STIMPSON: A neighbouring company have done otherwise.

The CHAIRMAN: Because they were insolvent, and said they could show that for many years to come the preference dividend could not be paid.

Mr. MATTHEW GRAY observed that if there was any chance of this Company getting into a state of insolvency, the preference shareholders would do wise to help it; but no doubt all who knew the circumstances of the Company would see pretty clearly that the preference shareholders were in a strong legal position, and were likely to hold on. There was, however, something to be said on the fact of a large reserve fund tending to give a better market to the preference shares, because a higher class investment was thus secured.

The CHAIRMAN: That is inseparable from the constitution and form of preference shares. We could not get the capital which was raised by preference shares on any other conditions, and we were very glad to get it on those conditions. My conviction is that the ordinary shareholders get as much benefit from the reserve fund in the long run as the preference shareholders.

Mr. STIMPSON stated that he had not intended to convey that it was unwise to make a judicious reserve fund; but that it would not be fair to the ordinary shareholders to make it too large.

The CHAIRMAN: There is something in that; but we are a long way off considering that matter yet. If you look at the cost of our cables, and the amount of our reserve fund, you will find that we have a smaller reserve fund than any company. Our reserve fund bears a very much smaller proportion to the cost of our cables than is the case with any other company, and if we wish this Company to maintain a solid position, we must continue our plan of adding to the reserve fund every half year till it gets much larger. When it does reach a considerably larger amount, it will be for us to consider whether we shall not reduce our half-yearly payments to the reserve fund.

Mr. GRAY said he quite agreed with the remarks of the chairman.

The CHAIRMAN: I hope we shall be in a better position when we meet you in the spring, but meantime we consider our position very good.

The proceedings then terminated.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The accounts of this company for the six months to the 30th June last show a balance of £12,621 on revenue account. The directors have decided, after placing £5,000 to reserve, to carry the balance of £7,621 forward. In consequence of the unusually heavy cost of repairs to cables during the past and current half years, the directors are unable to recommend a payment on account of the arrears of dividend on the preference shares.

BURGLARS BALKED.

On Wednesday last a number of gentlemen, many of whom were either bankers, diamond dealers, or large warehousemen, were shown by Messrs. Francis and Co., telegraph engineers, some further developments of their burglars' alarms, which have been previously alluded to in *The Globe*. The company were shown how the current of electricity could be attached in such a manner that the raising of a window, or the mere turning of a door handle immediately caused the ringing of a bell sufficiently loud to awaken the whole household. The inventor then went on to demonstrate that his latest discoveries in this direction would secure perfect protection of property against burglary. The attempt to raise a window or turn a door handle would cause a gong to be sounded, and at the same time indicates the part of the house in which the fastenings were being tampered with. Another new feature is one which will cause no little surprise to the midnight thief. No sooner does he raise a window than from a lantern, which up to then is apparently unlighted, there issue the fiercely bright rays of the electric light, illuminating the whole room, and setting in motion a gong so powerful that it can be heard for a considerable distance. Were it not that the English law forbids manslaughter except in self-defence, the lives of burglars breaking into houses where electricity is used would be short indeed. By a most ingenious contrivance a window, raised about a foot high, sets in motion a current which releases a guillotine, which would decapitate the burglar when he had made a partial entry of the premises. This latter appliance can, however, be modified by the substitution of a bar of wood, which would descend with sufficient force to stun the burglar and thus lead to his arrest. It was stated that, so far, not one single house amongst several thousands in London alone that had been fitted with the electric bell had been entered by burglars.—*Globe*.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES OCT. 4.		BUSINESS DONE WEEK ENDING OCT. 4. Highest.	Lowest.
Anglo-American	50,	51	51	50½
Do. Preferred	82,	83	83	82½
Do. Deferred	19½,	20½	20	20
Brazil Submarine	11⅞,	12⅛	11 15-16	11⅞
Cuba	9¾,	10¼	10	10
Do. Preference	16,	17	16¾	16½
Direct Spanish	6¼,	6¾	—	—
Do. Preference	13,	13½	—	—
Direct United States Cable	11½,	12	12	11⅝
Eastern Telegraph	10¾,	11	11	10 13-16
Do. 6 per Cent. Preference	13,	13½	—	—
Do. 5 per Cent. Debentures, 1899	101,	104	—	—
Eastern Extension	11⅜,	11⅝	11⅝	11 7-16
German Union	9⅞,	10¼	10¼	10⅛
Globe Telegraph and Trust Company	6½,	6¾	6¾	6⅝
Do. Preference	12½,	12¾	12¾	12 9-16
Great Northern	12¼,	12¾	12⅝	12⅜
Indo-European	30½,	31½	30½	30⅛
Mediterranean Extension	1⅞,	2½	1⅞	1⅞
Do. Preference	8,	9	—	—
Reuter's	12¾,	13½	—	—
Submarine	255,	265	—	—
West India and Panama	1⅝,	1⅞	1⅞	1⅝
Do. 1st Preference	8½,	9	8 11-16	8⅝
Western Brazilian	6¼,	7¼	6⅝	6⅜
West. Union 7 per Cent. 1st Mortgage	123,	128	127	127
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1⅛,	1⅜	1 5-16	1 3-16
Oriental	¾,	1	1 5-16	⅞
United Telephone	10¼,	10¾	10¾	10½

ELECTRIC LIGHT.

Maxim-Weston	½,	¾	¾	⅝
Anglo-American Brush	13¼,	13¾	13¼	12⅝
Eastern Electric	2,	2½	2½	2

TRAFFIC RECEIPTS FOR SEPTEMBER, 1882.

COMPANIES.	Sept., 1882.	Sept., 1881.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,250	2,030	220	—
Direct Spanish Telegraph Company	1,812	1,790	22	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	—	—	—	—
Eastern Telegraph Company	—	—	—	—
Great Northern Telegraph Company	—	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

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RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

4592. Improvements in Apparatus for Generating Electricity and for the Production of Electromotive Power, Parts of which Improvements are Applicable to other Purposes, *A. Millar, Glasgow.—20th October*, 1881. 8*d*.

This relates to an invention for enabling electric currents to be produced with less expenditure of mechanical power than heretofore, and to provide against loss of current in transmission through wires. The inventor claims the construction of a magneto-electric machine, the electro-magnets of which are surrounded with water to prevent heat; also the insulation of the wires in their coils by the process of "japanning," &c.

4654. Improvements in and connected with Incandescent Electric Lamps, *G. G. André, Dorking.—24th October*, 1881. 6*d*.

The inventor uses vegetable fibre, such as rattan, for his carbons, and immerses it in a mixture of one part nitric to four parts sulphuric acid, for from twenty to thirty minutes. The nitro-cellulose thus produced is then washed and immersed in a solution of nitro-cellulose in ether or alcohol, where it is allowed to remain until it assumes a semi-dissolved state; it is then removed, subjected to pressure, and cut to the shape required; it is then carbonised and the pores filled up by heating in a vessel containing hydro-carbon gas, or by other means. The carbon is then fixed in a glass globe to platinum wires, either by clamps in the ordinary way or by other methods, and the globe exhausted. The inventor claims the method of preparing the carbons, connecting them to the wires, and a method of procuring a vacuum in the glass globe by means of a column of mercury forced into it.

4780. Improvements in Insulating Electric Conductors, &c., and in the Material Employed for such Insulation, or for Waterproofing Purposes, *A. T. Woodward, New York.—1st November*, 1881. 6*d*.

The inventer uses a waterproofing and insulating material composed of silica, glass, or quartz in a powdered state, and vegetable or mineral resin or pitch, also ground fine. To these are added paraffin and boiled or raw linseed oil, the proportion being silica 66 parts; resin or pitch, 34 parts; wax, 26; and oil, 3. These are all combined by liquefaction, and wires drawn through the compound, or it is poured into the tubes containing the wires.

4824. Improvements in Electric Current Meters, *C. A. Carus-Wilson, London.—3rd November*, 1881. 6d.

This invention consists mainly of a method of obtaining a variable rotation of one shaft from another shaft rotating with a constant angular velocity; and, secondly, of means by which the pieces connecting the one shaft with the other are moved in accordance with variations in the current to be measured. The inventor claims the obtaining of a variable rotation of a shaft which works a counting apparatus from another shaft rotating at a constant angular velocity by means of two cones and an intermediate wheel, the angle which the axis of this wheel makes with the axes of the two cones, and therefore the speed of the shaft which works the counting apparatus, being varied by mechanical motion derived from variations in the current to be measured, said variations of angle being produced by combination with an electric motor and dynamometer. The inventor also claims the combination of all the above with a Wheatstone bridge and a rheostat.

4948. Improvements in and Connected with Electric Lamps, *G. G. André, Dorking.—11th November*, 1881. 1*s*.

This relates to arc lamps. The inventor feeds his positive carbon by a separate current, so that the feed is only applied when required, and then automatically. For this purpose he uses a shunt circuit in connection with feed magnets and feed-controlling magnets, which latter admit or refuse the entry of a current to the feed magnets, according as the arc requires adjustment or not, the said feed current passing through a relatively small independent wire common to a number of lamps, and the current being regularly intermittently supplied from some source by some suitable constantly revolving contact maker and breaker. The wire of the feed-controlling magnets is very fine, so as to take only a small portion of the lighting current if a short circuit is used. The positive carbon may be fed up by rack and pinion or otherwise. The inventor also provides an arrangement of a solenoid core and balance, combined with visible and audible signals, which is placed in the main circuit, and which gives warning of any irregularity in the current.

5050. Improvements in Apparatus for Automatically Transmitting and Receiving Signals for Denoting Places at which Attempted Burglaries and Robberies may be made, and for other Purposes, *F. R. Francis, Lawford-road, and C. Donovan, St. James's-square, London.—18th November*, 1881. 6*d*.

The inventors fix contact makers on doors, &c., and connect them by wires with an audible and visible signal at the nearest police station or other house, and a battery. The signal receiver consists of a number of electro-magnets corresponding to the number of contact makers; each magnet is provided with a balanced horizontal bar carrying a disc, which is maintained in its normal position by the armature of the magnet, so as to obscure the name or number of the door, &c., to which the corresponding contact maker is affixed. As soon as a circuit is established by the contact maker, the armature is attracted, releases the balance bar, causes the disc to fall, and exposes the name, &c., to view. A bell is also provided to give audible signals. The inventors claim the general construction of a system of burglar alarms as indicated above.

5070. A Telephonic Repeater, *C. Moseley, Manchester.—19th November*, 1881. 6*d*.

The object of this invention is to obtain the repetition in an earth return circuit of the undulatory current of a metallic circuit, or the reverse. This the inventor accomplishes by means of one or more induction coils. If one coil only is used, he connects the two ends of the metallic line with the two ends of one of the helices of the coil, so that the helix forms part of the closed circuit, the ends of the other helix being connected respectively to earth and to a single line wire.

5071. Improvements in and Connected with Telephonic Transmitting Apparatus, Specially Adapted for Pan-telephones, *E. de Pass, London.—19th November*, 1881.—(*A communication from L. de Locht-Labye, Paris.*)—(*Not proceeded with.*) 4*d*.

This consists in the combination with batteries of a sound receiving plate of unpolished wood or other material, of large surface but slight weight, and free to swing about one of its points of support; it carries a carbon contact piece, which bears against a stop of carbon.

5096. Improvements in Electrical Commutators, *W. R. Lake, London.—22nd November*, 1881.—(*A communication from F. Blake, Weston, Massachusetts.*) 6d.

The inventor combines with a pile of plates of metal and hard india rubber, put together alternately, a number of smaller metallic plates, one for each circuit, between which connections are to be made, the smaller plates being secured to one of the large insulating plates and a peghole extending through each smaller plate, and also through all the large ones. Pegs are provided, adapted to make connections between two of several insulated plates in a pile, and these two only, each pair of pegs being adapted for use with any of the line plates of the commutator, but with only one and the same connecting plate.

5159. Galvanic Batteries, &c., *R. E. B. Crompton and D. G. FitzGerald, London.—25th November*, 1881. 4d.

This invention refers principally to the formation of porous lead plates for use in secondary batteries. The electrodes are formed by mixing other materials with lead, and afterwards removing the component or components other than lead by heat, chemical, or electrolytic methods.

5198. Secondary Batteries, &c., *C. H. W. Biggs and W. W. Beaumont, Strand.—28th November*, 1881. 6*d*.

Two claims are made—one referring to the use of chambered or hollow porous electrodes, the other to the construction of the porous plates for secondary batteries. Lead is deposited in the shape of crystals from acetate of lead, and the deposit pressed by hydraulic or other pressure into the shape and consistence required.

5226. Improved Means of Joining or Coupling Branch to Main Conducting Wires or Cables for Electrical Purposes and of Insulating such Joints, *A. W. Brewtnall, London.—29th November*, 1881. 6*d*.

The coupling consists of two parts, a hook-shaped jaw to receive the main wire formed with a hole intersecting the hollow of the jaw to receive the branch wire, and a binding screw screwing up towards the jaw. The pressure of this screw causes the main wire to be tightly gripped in the jaw and held in forcible contact with the branch wire.

5229. Improvements in and Relating to the Utilisation of Electricity for Lighting or other Purposes, and in Apparatus therefor or to be used in Connection therewith, *W. R. Lake, London.—30th November*, 1881.—(*A communication from J. S. Williams, Riverton, New Jersey, U.S.*).—(*Not proceeded with.*)—4*d*.

The inventor proposes to produce light and heat by passing a current through pulverised particles of carbon enclosed in a transparent tube, the carbon being in vacuo.

5233. Improvements in and Relating to the Utilisation of Electricity for Lighting or other Purposes, in Apparatus therefor or Connected Therewith, and in Means for Producing or Manufacturing such Apparatus, *W. R. Lake, London.—30th November*, 1881.—(*A communication from J. S. Williams, Riverton, New Jersey, U.S.*) 1*s*.

This relates, first, to the construction of incandescent lamps. The inventor sub-divides his carbon into several sections, each of small candle-power, so that if one goes it does not make much difference to the total candle-power of all the sections. The carbons are in vacuo. According to another method the inventor surrounds his carbon core by molten glass. The invention relates, secondly, to apparatus for heating rooms by electric currents, the apparatus being combined with a circuit closer and a thermometer, so that a certain definite temperature can always be obtained. The inventor also proposes to heat water and cause it to circulate through a house by means of an electric current. Other means of heating are also described.

5261. Improvements in the Constuction of Secondary Batteries, *H. E. Newton, London.—1st December*, 1881.—(*A communication from E. Volckmar, Paris.*) 6d.

The inventor arranges a number of secondary couples in a single vessel, the plates he places horizontally one above the other in a closed water-tight vessel. Each plate is thus the positive electrode of one couple and the negative of the following couple, the first and the last plates forming the poles of the battey. This arrangement permits of the vessel being turned over, so as to reverse the position of the plates after the charging of the battery. The inventor claims reversible secondary batteries as above.

5303. Improvements in the Construction of Telephones, *J. Burton, Oldham.—5th December*, 1881.—(*Not proceeded with.*) 2*d*.

The inventor places discs of paper or other material between the diaphragm and the end of the telephone magnet to decrease the effects of induction.

5338. Improvements in Secondary Batteries, *D. G. Fitz Gerald, Brixton, C. H. W. Biggs and W. W. Beaumont, Strand, London.—6th December*, 1881. 6*d*.

This invention relates to the production of plates for secondary batteries. The method consists in drawing lead sheets between two metal surfaces, one of which is provided with a reciprocating motion of small range, and a number of fixed points, disposed so as to finely perforate the sheet. After perforation the plates are immersed in dilute sulphuric acid contained in a vessel from which air may be withdrawn, the object being to fill the punctures with the dilute acid, so as to produce a coating of lead sulphate within the perforations. The sheet so treated is then folded and pressed. The inventors also claim, in addition to the above, a method of constructing the plates by the electro deposition of lead on a fine net fabric, subsequently chemical treatment, with folding and pressing.

5631. Secondary Batteries, *J. S. Sellon.—23rd December*, 1881. 2*d*.

The frame upon which the active agent is put is of material not readily subjected to the influence of oxidation.

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SLIP

Jeddah.—Telegraphic communication has now been established by cable between Egypt and Jeddah, in Arabia.

The Telephone in Alexandria.—The Oriental Telephone Company's Alexandria Exchange was re-opened this week.

China.—The cable between Amoy and Hong Kong, announced in our last issue as being interrupted, is now repaired.

West Indies.—In addition to the interruption already notified, the cable between Guadaloupe and Dominica is now broken down.

Brazilian Submarine Telegraph Company. — The traffic receipts of this company for the week ended 6th inst. amounted to £3,986.

Thomas A. Edison.—We are informed that Mr. Edison has removed his office from Menlo Park, N.J., to No. 65, Fifth Avenue, New York.

Eastern Telegraph Company.—The traffic receipts of this company for the month of September, 1882, amounted to £57,271, and to £47,407 in the corresponding period of 1881.

Telegraphs in South Africa.—The revenue receipt of Cape Colony for July last from telegraphs was £5,205, against £5,359 for the same month of 1881, or a decrease of £154.

Eastern Extension Telegraph Company.—The traffic receipts of this company for the month of September, 1882, amounted to £32,955, and to £30,866 for the corresponding period of 1881, being an increase of £2,089.

Electric Lighting for Glasgow Harbour.—At the last meeting of the Clyde Navigation Trustees, the general manager, Mr. Keith, was requested to obtain offers for lighting the graving dock and general terminus quay with electric lights.

Lecture on Electricity.—A popular lecture on "Electric Light and Force" is to be given at the Town Hall, Oxford, on October 26, by Mr. Eric Bruce, of Exeter College. Arc lights and various incandescent lamps will be exhibited on the occasion.

Western and Brazilian Telegraph Company.—The traffic receipts of this company for the week ending 6th October, 1882, were £2,626, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

The Telephone at Glasgow.—The Clyde Navigation Trustees are considering the question of providing telephonic communication between the different parts of Glasgow Harbour. Their manager has been requested to obtain offers for carrying the work out.

Electric Lighting at Nine Elms Station.—The London and South Western Railway Company have commissioned Messrs. R. E. Crompton and Co. to light their Nine Elms goods station. Seventeen Crompton arc lamps are to be used, and will be at work shortly.

Legal.—Another Telephone Case.—News from Canada states that in the case of the Canadian Telephonic Company *v.* The Toronto Electric Despatch Company, a perpetual injunction was granted against the defendants, thus establishing the validity of the Bell Telephone patent.

Electric Light in Tin Plate Works.—Fifty Swan lamps have been erected in the tin plate works of Messrs. Morewood and Co., at Llanelly, in Wales, as an experiment. If they prove as useful as they are expected to be, it is probable that their number will be considerably increased.

Electric Light in Holborn.—A portion of Messrs. Laing and White's premises in Holborn has been lighted by means of Swan lamps. The power is derived from a two horse Otto gas engine, which drives a Bürgin machine. The lamps, &c., have been fitted up by Messrs. Crompton and Co.

Great Northern Telegraph Company.—The traffic receipts of this company for September, 1882, amounted to £21,280. For the period from 1st January to 30th September, 1882, they reached £181,840, against £180,279 for the corresponding months of 1881, and £176,646 for the same months of 1880.

New Telegraph Steamer.—It is stated that Messrs. David J. Dunlop and Co., of Port Glasgow, have contracted with the Government for the construction of a large iron cable steamer, to be fitted up with all the latest improvements necessary for the laying and repairing of submarine telegraph cables.

Jamaica.—According to the report of the Postmaster-General for 1881 the cash collection amounted to £16,984, that for the previous year having been only £14,222. The increase is mainly due to the improved earnings of the telegraph department, the wires having been greatly extended since the previous report was issued and the complete circuit of the island obtained

South America.—It is officially announced that telegraphic communication has now been established with the states of San Salvador, Guatemala, Honduras (Independent), Nicaragua, and Costa Rica in Central America; and with Ecuador in South America; and that telegrams can also be sent to Buenaventura and other places in the United States of Columbia besides Colon and Panama.

Proposed Duplication of Cables.—We have reason to believe that the Great Northern Telegraph Company are making the necessary preliminary arrangements for the duplication of all their cable lines in the Far East, to be effected at a very early date. This is in order to more readily meet the exigencies of the increased Chinese and Japanese traffic, both local and international.

The Telephone and Ballooning.—At the beginning of this week several ascents were made by members of the Academie d'Aérostation Météralgique, from the Place Saint Jacques, Paris. Amongst other things conversation was carried on with people on the earth by means of a telephone line suspended from the balloon. The height at which the balloon is said to have been was 500 feet.

Electric Lighting in Factories.—A portion of the extensive wool works of Messrs. W. and J. Don and Co., of Forfar, Scotland, has recently been lighted by means of Swan incandescent lights, supplied by the Northern Electric Light Company, of Dundee. The works of Messrs. J. Laird and Co., in the same town, are also lighted by means of arc lamps supplied by the same company.

Electric Light in Shops.—The establishment of Messrs. Peter Jones and Co., drapers, King's-road, Chelsea, S.W., has recently been fitted up with 200 Swan incandescent and four Crompton arc lamps. The current is generated by five Bürgen dynamos, driven direct from the fly wheels of two Otto Gas engines, placed in the basement of the building. The lights were supplied, and the work carried out by Messrs,

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R. E. Crompton and Co., of Mansion House-buildings, Queen Victoria-street, E.C.

A Telephone Cable.—On Saturday last a telephone cable was laid by the National Telephone Company across the Frith of Tay, nearly half a mile west of the Post Office cable, which lies between the Highlight and West Ferry. The work which was begun at 11 a.m., was carried out quite successfully, and at 2 p.m. a conversation was held with perfect distinctness from shore to shore. The cable is intended to connect the National Telephone Company's office in Dundee with Tayport and Newport.

Electric Light at Waterloo House.—The extensive premises comprising nearly the whole of the quadrangle formed by Cockspur-street, Trafalgar-square, Pall Mall East, and the frontage directly looking down Pall Mall, and which have for so many years been known as Waterloo House, and in the occupation of Messrs. Halling, Pearce, and Stone, have been furnished with a very successful installation of 16 arc lights by the Metropolitan (Brush) Electric Light Company, the motor being a 12 h-p. (nominal) Otto gas engine.

Discoveries of Magnetic Iron.—In sinking an artesian well on the premises of the St. Paul (Minn.) Harvester Works, says an American contemporary, magnetic effects were noticed. At the depth of 630ft. a hard stratum was struck, and operations continued to be very difficult for a distance down to 40ft. or more. On analysis, the substance of the harder rock proved to be magnetic iron ore, exceedingly rich in quality. A second well is to be sunk. Another artesian well, sunk at Yankton, Dakota, has also developed powerful magnetic properties.

The Telephone in Sunderland.—On the occasion of a concert being given in the Victoria Hall, Sunderland, on Monday last, the Northern District Telephone Company made arrangements by which a certain number of their subscribers could be coupled up with a circuit, including the hall, and thus have the benefit of the music in their own homes. Several of the singers' voices were recognised by listeners at various telephones, and this method of bringing the mountain to Mahomet, otherwise the music to those at a distance, was much appreciated.

Mersey Tunnel.—On the occasion of the visit of the Lord Mayor of London, the Mayor of Liverpool, and a distinguished company last Wednesday, the 11th inst., to this place, the tunnel was brilliantly illuminated with the electric light. A Brush dynamo machine was used, together with fifty candle-power Lane-Fox incandescent lamps. The whole work has been placed in the hands of the Hammond Electric Light Company, Liverpool, and has been efficiently carried out under the superintendence of Mr. James Shaw, the district manager, and Mr. Rowley, the electrician to the company for this district.

The Telephone in Collieries.—The National Telephone Company of Dewsbury have just completed a system of telephonic communication for Messrs. Henry Briggs, Son, and Company (Limited), Whitworth Collieries, near Normanton, connecting their Saville and Methley Junction pits and their chief engineer's residence with the head offices at Whitwood, also connecting the bottom of their Silkstone pit with the bank and the offices. The depth of the Silkstone pit is 420 yards. The work has been done under the supervision of the company's manager, Mr. Frank Lumley. The instruments are said to work well in the pit.

Electric Light at Berechurch Hall.—A short time since we announced that Mr. O. E. Coope, M.P., was going to light his country seat, Berechurch Hall, near Colchester, by electric lamps, and had entrusted the work to Messrs. R. E. Crompton and Co. Some two hundred Swan lamps have already been fitted up, and the various circuits will be in working order within a short time. The current is generated by Bürgin dynamo machines of the ordinary shunt type, four of which are in use. The power is derived from a twelve-horse engine by Messrs. Davey, Paxman, and Co., of Colchester.

Southwark and Electric Lighting.—The Vestry of St. George-the-Martyr, Southwark, took an important step at a meeting on Monday evening with regard to the electric lighting question generally. Acting on the suggestion of Mr. Edward Yates, it was resolved to oppose the application of all companies for licenses, under the third section of the Electric Lighting Act, unless they were prepared to guarantee to the Vestry that, after paying a dividend of 7½ per cent., one half of all profits accruing beyond should be handed over to the Vestry towards the reduction of the local rates, in consideration of the concession granted for the laying down of the necessary works.

Cutting Telephone Cables.—A disgraceful act of vandalism has recently come to light in Newcastle-on-Tyne. It appears that many of the underground cables belonging to the Northern District Telephone Company in that town, or rather city, have been maliciously cut by some persons unknown. The company have offered a reward of £50 for such information as shall lead to the conviction of the offender. We sincerely trust that he will be caught, and made an example of. A more stupid or wilfully malicious act can scarcely be imagined, and we trust that the punishment meted out will be in proportion to the inconvenience and trouble caused to the public by reason of the act.

Electric Lighting at Chesterfield.—Mr. G. E. Gee, of High-street, Chesterfield, writes to the *Standard* of Thursday as follows in reference to the lighting of that town by means of electricity:—"After waiting many weary months for the completion of the incandescent lighting, it is now, when declared by the contractors complete, in my opinion, a decided failure." He goes on to say that while some of the arc lights do good service, the result of a year's trial shows that the field for arc lighting is "very limited indeed." Mr. Gee concludes, however, by expressing the belief that "the time will shortly come when lighting by electricity may be advantageously adopted, both for public and private purposes."

Electric Lighting in Dundee.—The galleries of the Dundee Fine Art Exhibition are now lighted by sixteen Siemens arc lamps, the current being derived from a Siemens' alternate current machine, driven by an engine lent by Messrs. Lipman and Co., of Meadowside, Dundee. The lighting will be continued during the three months that the exhibition is to remain open. The work has been carried out by the Northern Electric Light Company, of Dundee, under the superintendence of their engineer, Mr. Lewis Nebel. A local paper, reporting the event, remarks:—"The coolness and comfort of the galleries this year are in marked contrast with the excessive heat which attended previous exhibitions, when two hundred or more gas jets were in use."

New Company.—The Electromotive Force Company, Limited, with a capital of £25,000 in £10 shares, was registered on September 18. It has for its primary objects the working of four of Mr. Alfred R. Bennett's patents, viz., two for voltaic batteries, one for telephonic translators, and one for improved means and appliances for the prevention of corrosion in boilers. The offices of the company are at 6, South

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Hanover-street, and the works at 30, Hill-street, Garnethill, Glasgow. The secretary is Mr. D. Johnstone Smith, and the manager Mr. Bennett himself, who nevertheless continues to act as Messrs. D. and G. Graham's engineer. Both the batteries and translators have been in operation for some time past on the Scottish lines of the National Telephone Company, and have given great satisfaction.

Owens College, Manchester.—Professor Arthur Schuster, assisted by Mr. W. Haldane Gee, is announced to give a theoretical and practical course on the technical applications of electricity on Thursday evenings, from seven to nine o'clock, in the physical laboratory of this college. The syllabus of the class includes measurements of current, electromotive force, and resistance, various current producers, current measurers, their construction, &c.; construction of telegraph lines; explanations of the telephone and microphone, magneto and dynamo-electric machines, and electric lighting. The class will have at its disposal a Wilde dynamo-electric machine, and measuring instruments. The ee for the class is £2 2s. All communications should be addressed to Professor Arthur Schuster, at the college.

The Congress at Paris.—The International Congress to be held at Paris next week, to consider what means are to be taken to ensure the safety of submarine cables will be attended on the part of Germany by Professor Dambach and (Naval) Captain Donner, while at the Congress of Electricians, meeting at the same time, the Empire will be represented, among others, by Professors Helmholtz, Wiedemann, and Kohlrauch and Geheimrath Ludwig. Her Majesty's Government will be represented at the first of these congresses by Mr. Kennedy, C.B., of the Foreign Office; Mr. Trevor, Assistant Secretary to the Board of Trade; and Mr. Patey, Third Secretary to the Post Office. Lieutenant-Colonel Bateman-Champain will represent the Government of India. Mr. H. Farnall, of the Foreign Office, has been appointed secretary to these gentlemen.

Overhead Wires; their Latest Offence.—Accidents due to overhead telegraph wires are so often of a serious character that it is some relief to hear of one at which the humane, as well as the profane, may be permitted to laugh. In connection with the religious pageant witnessed at Cairo last week a good deal was said about a wonderful Holy Carpet which had to be solemnly borne through the streets on the back of a stately camel. Whether the hump of the animal was inordinately high, or the span of the telegraph wires across the route was unpardonably low, we are unable to say; but certain it is that on passing under one of them the sacred symbol was swept off the camel's back, and exposed to the unholy gaze of an unbelieving crowd. The bearer escaped uninjured. It is thought that a brand new Holy Carpet will have to be woven—after all, a much easier thing to do than to make a new camel.

Electric Lighting in the Paris Opera House.—A very successful installation has just been completed with Swan lamps and Faure accumulators in the Paris Opera House. The lamps were first shown to the public on Friday, September 29. They have been placed in several parts of the building, but most prominently in the *foyer*. To light the *foyer* with gas, ten chandeliers, with 48 lights on each, were used—equivalent to about 4,800 candle-power. Two of these chandeliers have been fitted with 48 Swan lamps each. These were run up to about 40 candle-power, making a total of 3,840 candles for the two chandeliers—almost exactly equal to the eight remaining gas-lit chandeliers. The effect in the neighbourhood of the electric light was very remarkable, and the representatives of the opera house who witnessed the trial expressed themselves extremely pleased with the result. All the main cables were covered with lead, and every lamp was protected with lead cut-outs to avoid any possible chance of fire.

Central and South American Cables.—The laying of the Central and South American Company's cables has, at length, been completed by the India Rubber, Gutta Percha, and Telegraph Works Company, of Silvertown, and congratulatory messages exchanged between the President of the United States and the Presidents of the Republics of Central and South America. The cables are laid from the coast of Mexico to Valparaiso in South America, and consist of short lengths between the various towns on the sea coast, the total length being about 3,000 miles. They lie for the most part in shallow water. We gave diagrams of the sections, shore ends, intermediate and deep sea of the cable in our issue of 20th May last, together with a map of the route taken. We shall hope to give further particulars of the work of laying the cable in a future number. For the present we may mention that the whole of the work has been successfully carried out under the superintendence of the company's chief engineer, Mr. Gray, who, together with his staff, is to be congratulated on the achievement.

Proposed Underground Metropolitan Railway at Vienna.—A very important work is now in contemplation, and, indeed, will probably be commenced very shortly at Vienna, which will render that city in respect to railway accommodation pretty much on a level with the English metropolis. At present the chief lines of railway converging on Vienna do not enter the populous part of the city, and the proposal under consideration is intended among other advantages to remedy this defect, so that passengers may be brought, as in the case of London, to points nearer to their final destination. The whole city is to be encircled by an underground railroad, which will, of course, form junctions with the several railway termini in the suburbs. In connection with this undertaking it is suggested that as the Danube is close by, its waters might be utilised for generating electrical power amply sufficient to carry the traffic, and the tunnelling might thus be maintained free from the smoke and steam which render our own underground railways so disagreeable and unwholesome.

Incandescent Lamps and Big Guns.—On board H.M.S. "Devastation" the other day some interesting experiments were made to ascertain what effect the concussion following the discharge of her big guns would have on incandescent lamps. With this object 22 lamps, some alight and others unlighted, and consisting of the Swan, Edison, and Maxim types, were placed inside and around the turrets, four of the Swan lamps being fitted over the breeches of the guns. It was also intended to test the effect of the firing upon a powerful search light, which had been fixed upon the superstructure deck. Unluckily, as soon as the lamp was put in circuit the glass face was broken by the intense heat, and the carbons, being unprotected, were destroyed by the fourth round. At the third round a Swan lamp, one side of which had been accidentally broken, was completely smashed; while at the fifth round the springs by which a second Swan lamp was suspended were injured, and allowed the interior globe to fall upon the outer globe and extinguish the light. Both these lamps were fixed outside the turret. The other lamps withstood the shock of the guns without injury.

Vagrant Electricity.—The *Standard's* New York correspondent telegraphing on Sunday night last says:—"The danger caused by the current of electricity escaping from the

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underground wires has caused much comment of late, and a fire which occurred yesterday in a suburban church is attributed to this cause. Mr. Edison asserts that his household system has proved an entire success, but the rumours as to the escape of the current have prevented his service being supplied to more than fifty houses." This is making an ogre of electricity with a vengeance. It is evidently looked upon as a kind of underground fire, which may crop up anywhere at a moment's notice, as frequently occurs in mining districts in the north of England at the present time. Visions, no doubt, haunt timid New Yorkers of currents of electricity rushing along their gas, water, steam, &c., pipes, heating them red hot, and then conflagration. And all this effected by one central station of a system which produces low tension currents only, and the conductors of which are, as a matter of course, constantly being tested, and where the more current that escapes the worse for the system. Really this is "much ado about nothing."

The Cost of Electric Lighting.—An article under this head appeared in a recent issue of the *Daily News*. It professed to give the cost of electric lighting by means of the Ferranti system, about which so much has been heard of late, the figures being taken from a price list issued by the company working this system. Without expressing any opinion as to the merits of the Ferranti dynamo, or the cost of the system, we may say that we are in accord with our contemporary, the *Journal of Gas Lighting*, when he says:—"The writer of the article, however, has his misgivings about the value of his figures, and accordingly hastens to acknowledge that the gas is taken at its retail price, while the Ferranti estimate is the cost 'without addition for officers, collectors, and so forth.' Very large additions might, therefore, be covered by this elastic phrase; and so far from the 'cost' being given by the estimate, the figures are thus admitted to be only an imaginary proportion of the real cost. The writer goes on to say that his 'comparison, nevertheless, gives an idea of what can be done in the way of supplying electric light on a large scale.' We submit that it does nothing of the kind; it merely shows what may be done in the way of advertising on a large scale, when newspaper editors are complaisant, and writers not over scrupulous."

Electric Lighting at Pentonville.—A first trial of the lamps that have been erected by the Maxim-Weston Company at Pentonville-hill and the neighbourhood was made last week in the presence of several members of the Clerkenwell Vestry. The lamps have been erected under a contract with the vestry, and are to take the place of gas for a certain period. A station has been established in Chapel-street, Penton-street, N., whence the current, generated by Maxim machines driven by one of Ransomes' engines, is distributed to the lamps. These latter have been fitted up by pairs in the ordinary gas lamps, which number is increased to four in the "refuge" lamps—the Maxim lamp being of 50 candle-power. It will be seen that a good light is the result. The permanent lighting will begin in a few days, when we shall hope to give our readers a few more particulars of this, the second installation of incandescent lighting in London, and which gives every sign of being a worthy representative of its class. Our friends of the daily Press are apparently still rather bewildered as to the composition of an incandescent lamp, and in the case of the Maxim lamp in particular one reporter makes the bold statement that "there were altogether 82 lamps supplied with the platinums, and the effect produced by the 50 horse-power engine employed as the power generator was very satisfactory." There are at least three mistakes in the above sentence.

A Large Electro-plating Establishment.—Professor Silliman, of Yale College, pronounces the electro-plating establishment lately acquired by the Postal Telegraph Company, at Ansonia, Conn., the largest in the world; yet its capacity is soon to be trebled. The works are employed in copper plating the steel wire used in the company's system of telegraphy, and now deposit two tons of pure copper a day. The steel core of the wire gives the required tensile strength, and the copper covering extraordinary conducting power, reducing the electrical resistance to such a degree, the company claim, that San Francisco may be brought, telegraphically, nearer New York than Chicago is now. When the plant is completed, three three-hundred horse-power engines will drive dynamo machines to supply current for electro-plating thirty miles of wire a day, the wire carrying five hundred pounds of copper to the mile. In the process of coating the wire is drawn slowly over spiral coils through vats containing copper in solution, until the proper thickness of deposit is obtained. The *Scientific American* says that the first line of the Postal Telegraph Company will run from New York to Chicago by way of Binghamton, Elmira, Corry, Pa., and Cleveland, Ohio; but there will be no way stations, the company preferring to do what is called "trunk line" service. The lines will be constructed with forty poles to the mile, and are to be completed by December. A line is promised to Boston by the same date.

Crystal Palace Exhibition.—The amount subscribed by the gas companies towards the expenses of the special committee of the Gas Institute in connection with this exhibition now reaches £5,046. With reference to this expenditure, we may take the following from the *Journal of Gas Lighting*:—"It has been decided that the general funds shall be devoted to lighting the nave of the Palace from the Entertainment Court, made memorable by the display of Edison lighting last spring, to the end by the crystal fountain. This is just half the length of the building; the remainder, towards the tropical end, being given over to the electricians. It should be observed that the plan of the lighting of the nave has not yet been settled by the executive committee. It may be assumed that the great length of the portion under their control will be taken advantage of for the purpose of displaying variety in the methods of lighting large areas. The lighting will be designed on an economical basis, since it is intended to publish particulars of the cost of the different arrangements. It is scarcely necessary to remind a committee of gas engineers that the real brilliancy of artificial lighting depends—not, as the electricians vainly imagine, upon the intensity of the sources of light, but on the absence of dark spots within the area supposed to be illuminated. It may be confidently expected that when the productions of Herr F. Siemens, Sir James Douglass, Messrs. Sugg and Co., Messrs. Bray and Co., to say nothing of the minor lights, are massed in the nave, there will be little room for shadows there. The light of these lamps will shine down upon the collection of apparatus illustrating the domestic and industrial applications of gas; and also upon the exhibits of residuals and apparatus connected with gas manufacture and distribution. The picture gallery will also be lighted up by improved gas burners; and some furnished rooms, such as attracted so much admiration at the last exhibition, will be shown lighted in all cases with ventilating burners. In addition to all this, which will be done under the direct control of the executive committee, several of the Courts will be lighted, on their own behalf, by the proprietors of different systems of gas lighting."

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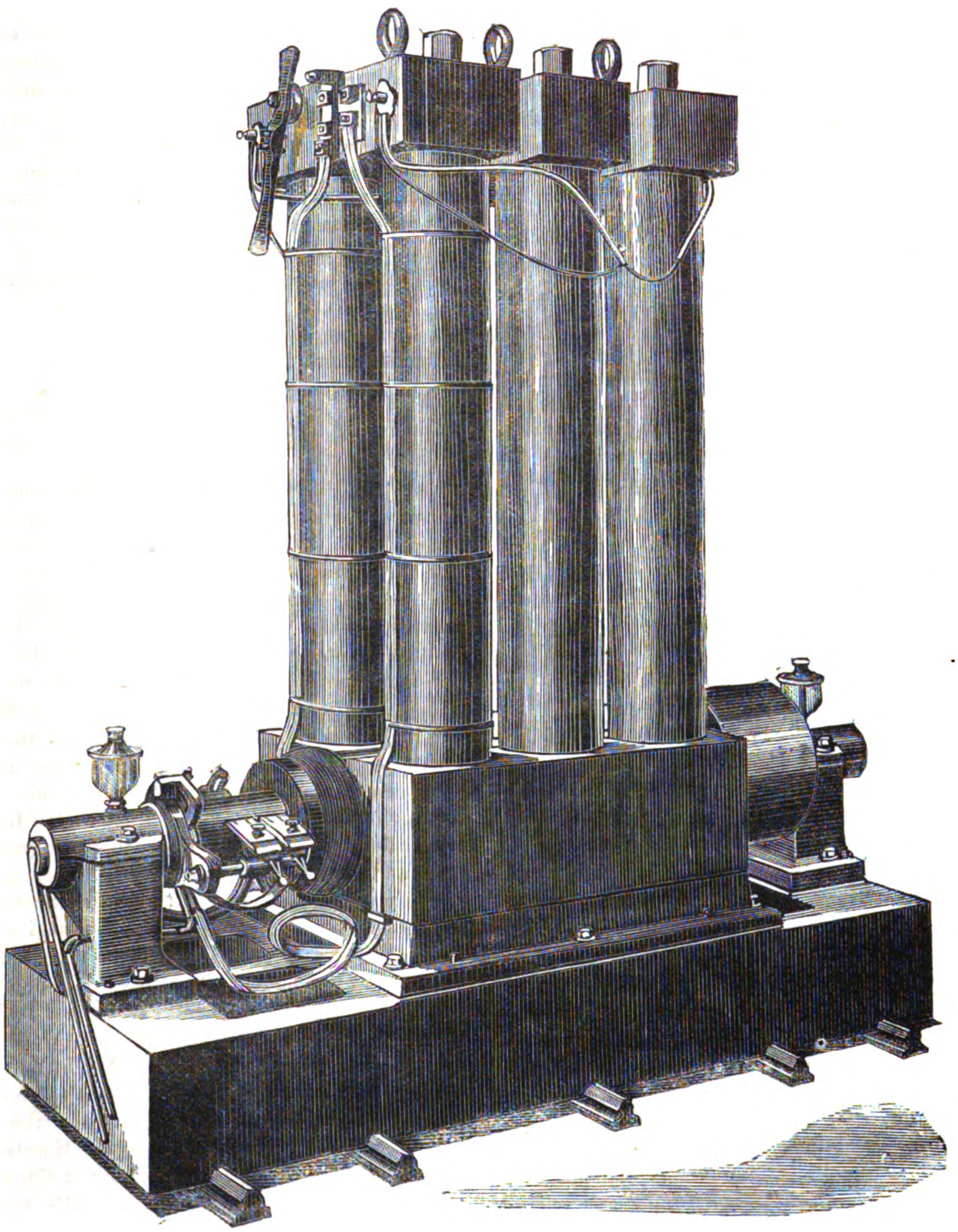
THE MUNICH EXHIBITION.—II.

Considering the importance of retaining the lead in a new business, it is difficult to understand why it is that some of the best known lights are so inadequately represented. Talking a day or two ago to a casual acquaintance about the progress of the electric light, he remarked there is no doubt that Edison has done more for the electric light than any other man or any other firm. This statement can hardly be denied. Wherever the Edison people exhibit their work is mination shown to obtain and hold the lead in incandescent lighting, we must give them the highest credit.

So far as original apparatus is concerned there is little in Edison's exhibit to be described. The lamps are the ordinary 16 and 8 candle lamps, mostly 16 candles. We certainly think that the candle-power of the lamp should be increased, and we think the raising the normal lamp to 20 or 25 candle-power would be a step in the right direction. That our ideas are not original may be gathered from the fact that, in the street lighting



Edison's K Dynamo, for 250 Lamps.

certain to be carried out in an able manner, to a practical extent, and with a view to make as much as possible of the opportunity. The largest exhibit is not always necessarily the best, but surely an exhibit of from 500 to 1,000 lamps is far more effective than the exhibit of 10 or 20. At Munich we should say that Edison has at least four lamps for each one of all the others put together. They are to be found in their own special rooms, in the bar of the restaurant, in the stage and body of the theatre, and so on. This being the case, and considering the energy and deter- at Munich by the Edison people, a group of three lamps is placed upon each post. These three lamps give nominally a light of 48 candles, instead of the 32 candles from two lamps, as generally used. The street lamps are driven from a machine on the opposite side of the building to those used for the lamps inside the exhibition. This dynamo is driven by an Otto gas engine, with two cylinders, which seemed to work admirably, smoothly, and silently.

The dynamos used to supply the lamps in the exhibition are of a different type to those we have seen in England. So

far as we can gather Edison manufactures six types of dynamos, viz.:—

1.	1,200 lights (16 candle) dynamo, known as the	C.
2.	500	„ „ „ „ „	R.
3.	250	„ „ „ „ „	K.
4.	150	„ „ „ „ „	L.
5.	60	„ „ „ „ „	Z.
6.	15	„ „ „ „ „	E.

The three dynamos at Munich used for the exhibition lights are of the type K, to supply the current for 250 lamps. This machine, which we herewith illustrate, is practically obtained by the combination of three Z machines, as will be seen from the drawing. It will be noticed that in this, as in other of Edison's machines, the edges of the brushes impinge against the commutator instead of the brush being placed tangentially at the point of contact.

Great stress is always laid by exhibitors of Edison's system upon the fact that it is a complete system, and that Mr. Edison was the first to study the details of a system and provide for the many minor requirements. The arrangements made to obviate danger from fire are due to this foresight, and gave rise to the safety plug. We believe that the size of the wire and the composition of the alloy used by Mr. Edison for safety plugs is not altogether a secret, and that we shall not be breaking faith in giving the following details. The following, therefore, is a list of the size of wire required in safety catch plugs in installations of the Edison light:—

Gauge of Wire B.W.G.	Dia. in inches.	No. of Lamps.
25	·020	3
21	·032	6
19	·042	9
18	·049	12
16	·065	15
14	·085	20 to 25
13	·095	30 to 35
12	·111	40 to 45
11	·120	55 to 60

Composition of safety plug = 60 per cent. lead and 40 per cent. tin. The column of lamps is for A (16 candles) lamps, or B (8 candles) lamps when the latter are on a B line. Whilst giving figures we may as well continue, and take the following from a pamphlet entitled "Das Edison-Light," showing the latest figures given as regards candle-power, resistance, &c.:—

	Candle-power.	Resistance.	E.M.F.
A lamp	16	140	103 volts
„	32	70	103 „
B lamp	8	70	56 „
„	10	250	103 „

Taking these figures, and the formula per h.-p. $= \frac{C\,E}{746}$ or $\frac{E^2}{R \times 746}$, we see that nearly 10 A lamps per h.-p. are obtained, or about 160 candles per h.-p. We some time since (*vide Electrician*, Vol. VIII., p. 231) described Mr. Edison's system of conductors. The following figures give the sectional area of the conductors and diameter of the tubes containing the conductors commonly used:—

No.	Sectional area.	Dia. of tubes.
1	830 sq. mm.	82 mm.
1½	598 „	76 „
2	443 „	70 „
2½	340 „	65 „
2¾	244 „	58 „
3	133 „	51 „
4	92 „	48 „
5	54 „	33 „
6	33 „	33 „
7	16 „	28 „

The conductors are of copper, surrounded by a special insulating material, and placed within iron tubes. With the progress of electric lighting the question of cost of conductors will become a serious one, and as copper seems to be the best material, the outlook for owners of mines of this material is very good.

THE ELECTRIC LIGHTING ACT, 1882.

(45 AND 46 VICTORIA, C. LVI.) 8 al-546

BY WILLIAM GRIFFITH, ESQ., BARRISTER-AT-LAW.

Some years since we listened with admiring attention to lectures upon electricity delivered by an eminent authority, who has since been promoted to a seat on the judgment bench of the High Court of Justice. The interval which elapsed between the daring experiment that drew lightning from the cloud and the publication of the "Correlation of Forces" was about a century. Franklin's experiment produced little fruit. It is true that the church steeple and the powder magazine still raise aloft the lightning-conductor, and attract and bury the splendid meteor in the ground. But during the last thirty years we have learnt to value and use the meteoric fluid. Each of our ten larger railway companies, which together own more than five-sixths of the thirteen thousand metalled miles, has at least its trunk lines tracked by the telegraphic wires, which speed over hill and dale the latest intelligence of foreign and domestic weal or woe, and diffuse it through each commercial centre of life. The sea no longer retards the intercourse of one nation with another. The submarine cable connects France with England. The Anglo-American and the Direct United link together the races which speak the English tongue. To use the eloquent words of Mr. Henry M. Field, in his "History of the Atlantic Telegraph":—

'Tis done! the angry sea consents;
The nations stand no more apart,
With clasped hands the continents
Feel throbbings of each other's heart.

But east as well as west the lightning carries our messages. The Eastern Telegraph assists our power in Egypt, and the Eastern Extension supports our rule in India, enriches our merchant princes who trade with the Antipodes, and send the cottons of Manchester and the hardware of Birmingham to Australia and New Zealand. And still the progress continues, the darkness of night is dissipated by a light genial, brilliant, and diffusive as the sun at noonday. With a steady brightness, free from sulphuric acid and sulphuretted hydrogen, free from ammonia and other elements destructive of health, pictures, and books, we now illuminate our large libraries and halls of entertainment, our railway stations, and other places where men do congregate, and now we are introducing the cheerful atmosphere into our private dwellings. The legislature of the country anticipate the general use of this new light, and have passed an Act of Parliament to regulate its creation and supply, and the trafficking therein, not merely in a particular locality, but universally, in town and country, by urban and by rural authority, by companies empowered by the Board of Trade, or by special Act of Parliament, and by other persons whose enterprise keeps them abreast of the age. The universality of the operation of the Electric Lighting Act is apparent from the second section. Thereby the provisions of the new law are made applicable to every local authority, company, or person who may be authorised to supply electricity within any area, and to every undertaking so authorised, except so far as may be ordered otherwise by special Act of Parliament. In the metropolis, the local authorities are the Mayor, Commonalty, and citizens, acting by the Commissioners of Sewers, the Metropolitan Board of Works, the vestries of parishes in Schedule A of the Metropolis Management Act, 1855, and the district boards in Schedule B thereof. The residue of England is covered by the urban sanitary authorities and the rural sanitary authorities. What these urban, sanitary, and rural sanitary authorities are, we proceed to explain. The Public Health Act, 1875, divided the whole of England into districts, to be called respectively (1) urban sanitary districts, and (2) rural sanitary districts, and subjected such districts of the first class to urban sanitary authorities, and of the second class to rural sanitary authorities. Speaking generally, and omitting the qualifications necessary in exceptional districts, the urban authorities are (*a*) the mayor, aldermen, and burgesses, acting by the council; (*b*) the improvement commissioner; (*c*) the local board. The area of

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any union which is not connected with an urban district, nor wholly included in an urban district, with the exception of those portions (if any) of the area which are included in any urban district, is to be a rural district, and the guardians of the union shall form the rural authority of such district (38 and 39 Vict., c. 55, ss. 6 and 9). The power of granting licenses to the said parties, authorising them to supply electricity for public or private purposes within any area is confided to the Board of Trade, to whose energetic president the community is indebted for carrying the new statute. The consent of the local authority is a prerequisite to the grant of any license to be exercised within its area; and a resolution of a special meeting, convened after one month's previous notice, is necessary to enable the local authority itself to obtain the license. The Right Hon. J. Chamberlain and his coadjutors may make such regulations as to the limits within which and the conditions under which a supply is to be compulsory or permissive, and for the performance by the licensees of their duties as may be thought expedient. The license is not to continue for more than seven years, but it is renewable. In lieu of a license a provisional order may be granted by the Board of Trade without the consent of, but not without notice to, other parties, and unlimited in respect of duration. Such provisional order is to be of no force unless and until it is confirmed by Act of Parliament. Nevertheless, we are of opinion that where the undertaking is of any magnitude special and direct application to Parliament is desirable. Parliament as it possesses unlimited power so is it usually more generous in giving special powers than delegated authorities are. The special Act has the further advantage that it may bring together all the company's rules as to capital, direction, membership, &c., as well as those relating particularly to the electric undertaking. The regulations and conditions to be inserted in any license, order, or special Act, and which are to be obeyed by the undertakers regard :—

" (*a*) The limits within which and the conditions under which a supply of electricity is to be compulsory or permissive;

" (*b*) The securing a regular and efficient supply of electricity;

" (*c*) The securing the safety of the public from personal injury, or from fires or otherwise;

" (*d*) The limitation of the prices to be charged in respect of the supply of electricity;

" (*e*) The authorising inspection and inquiry from time to time by the Board of Trade and the local authority;

" (*f*) The enforcement of the due performance of the duties of the undertakers in relation to the supply of electricity by the imposition of penalties or otherwise, and the revocation of the license order or special Act where the undertakers have in the opinion of the Board of Trade practically failed to carry the powers granted to them into effect within a reasonable time, or discontinued the exercise of such powers."

The foregoing classes are special, but they do not restrict the Board of Trade with regard to other matters, or from making and substituting new regulations for securing the safety of the public from personal injury, or from fire or otherwise. For the same purpose the local authorities may make bye-laws imposing penalties.

The "undertakers"—we confess that we prefer the old word promoter to the term employed by the draughtsman of the Act—the undertakers are empowered under their license, order, or special Act, not only to supply electricity, but also, notwithstanding the Statutes of Mortmain to acquire lands by agreement, construct such works, acquire such licenses for the use of patents, enter into such contracts as may be necessary and incidental to such supply. One class of undertakers, namely, local authorities, may contract with a company or person for the execution and maintenance of necessary works, yet they cannot divest themselves of legal powers nor of legal liabilities imposed on them by the Electric Lighting Act, or by license, order, or special Act, until they obtain the consent of the Board of Trade.

So great was the development of the commercial energies of the country in the year 1845 that Parliament deemed it necessary to consolidate in certain general Acts clauses which were usually inserted in private Acts for the formation of railways or other companies. One of the most useful of these consolidating statutes has to do with the taking of lands for undertakings of a public nature, for no land can be taken against the will of the owner without parliamentary authority, and even with that authority full compensation must be paid. Section 12 of the Electric Lighting Act, 1882, incorporates this last-mentioned Act, excepting, however, the enactments with respect to the entry upon lands and those with respect to the purchase and taking of lands otherwise than by agreement.

The powers thus conferred are most important. Certain sections enable corporations, tenants in tail, married women whether of age or not, executors, and other persons under disability to sell and convey or release the lands or any estate or interest therein to the undertakers. Others provide for the application of purchase-money or compensation coming to parties having limited interests or prevented from treating or not making title. Others regulate the cases of intersection of lands; of enfranchisement of copyholds; of compensation for commons; of lands in mortgage or charged with rents; of lands subject to leases; of interests omitted in the original purchase; and of the re-sale of superfluous lands taken by the promoter of the undertaking by virtue of the Lands Clauses Act, or any special Act, or any Act incorporated therewith. The provisions of the Lands Clauses Amendment Act are few, but too technical for notice here. It must now be evident that if all these clauses were repeated in our Act, it would be very bulky and cumbrous, and even then of little greater use to the outside public. For questions of title to land and conveyancing ought never to be settled without taking the advice of those who are learned in the law.

Section 12 also incorporates the provisions of the Gas Works Clauses Act, 1867, with respect to the breaking up streets for the purpose of laying pipes, and with respect to waste or misuse of the gas, and injury to the pipes, or other purposes, substituting for the word "gas" "electricity," and for "pipe" "electric line." It excepts so much as relates to the use of any burner other than such as has been provided or approved by the undertakers, who, by Section 18 of the Electric Lighting Act, are prevented from prescribing any special form of lamp.

The incorporated provisions of the Gasworks Clause Act, 1847, are somewhat restricted by Section 13 of the Act before us, which requires, before any street is broken up, or any railway or tramway, the consent of the parties usually liable for repair. This is as it should be, and the Board of Trade can control the matter if the consent is vexatiously withheld.

The interpretation clause makes the word "street," literally the *via strata* or paved way of the Romans, to include "any square, court, or alley, highway, lane, road, thoroughfare, or public passage or place within the area." A recent case upon the word is Taylor *v.* Corporation of Oldham. There Jessel, M.R., held it to include a private road in a city having houses on one or both sides (L. R. 4 Ch. D. 409).

The same section—Section 12—also incorporates Sections 38 to 42, 45, and 46, of 34 and 35 Victoria, c. 41, commonly called the Gasworks Act, 1871. The Gasworks Clauses Act, 1871, by Section 38 imposes a penalty for injuring meters, by Section 39 protects incoming tenants from liability to pay arrears of gas rent left by the outgoing tenant, by Section 40 to 42 furnishes a means for recovery of rents. Section 45 provides that every notice required by the Act to be served by the undertakers upon any person may be served by being delivered to him or being left at his usual or last place of abode, and Section 46 enables justices or judges who would be otherwise disqualified by their interest in the rent or charge to act notwithstanding. The Electric Lighting Act supplements the foregoing clauses, and by virtue of Section 21 thereof the following remedy exists :—Whenever a local authority, company, or person neglect to pay the charge for electricity or the supply thereof, the undertakers may cut it off, and may cut or disconnect any supplying line or other work until such charge and expenses are fully paid, then their power to discontinue the supply ceases.

(TO BE CONTINUED.)

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CORRESPONDENCE.

WHAT IS ELECTRICITY?

Animal and Vegetable Life.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I shall now endeavour to show the mode in which—according to the foregoing theory—vital force, vital energy, or vital power correlates with terrestrial magnetism.

As I have already shown the manner in which the force of the sun correlates with magnetic force, it will be unnecessary to enter further upon that consideration in the present paper.

Terrestrial magnetism is universal, and therefore pervades every form of matter in a degree varying with the molecular and other physical conditions of the matter; in other words, every form of matter, as is well known, has a definite capacity for magnetic force, with which it is at all times fully charged in a degree varying with the temperature and other physical conditions of the matter.

Vital action, whether in the animal or vegetable kingdom of nature, is sustained by the motion of a nutrient pabulum, which by some means not only nourishes the tissues, but also imparts the energy by which the tissues are brought into existence, and the function of every organ is performed.

The theory now put forward is that the motion of the blood is productive of acceleration of the earth's magnetic force or energy—with which each tissue and each molecule of the nutrient pabulum is pervaded—in a direction according with its own motion, and in a degree determined by the resistance, or conducting powers, of the various tissues, and that this force, energy, or motion constitutes the force by which every chemical or molecular change or vital act is performed.

It will, perhaps, conduce most to the apprehension of the theory if we consider it first in the higher grades of animal life, where the phenomena are most marked, and are capable of being noted with great accuracy; and then, applying the same principle, observe how far it extends to all forms of life in both kingdoms of nature.

The blood or nutrient fluid by which life is sustained in the higher forms of animal life is composed of a solid and a liquid portion; the former called the blood corpuscles, the latter the liquor sanguinis. It will also be convenient to recognise that it exists in two conditions: 1st. the arterial, by means of which the powers of life are stimulated; and 2nd. the venous, which by its circulation through the tissues has been rendered incapable of arousing energy, and in other respects has been rendered unfit to carry on life.

It is desirable, in the first place, to ascertain the physical differences which exist between the arterial corpuscles, which are capable of stimulating the nerves, and the venous corpuscles, which have not such power.

We first note that the corpuscles are highly magnetic in both the arterial and venous states, and, secondly, *that the magnetic energy is greater in the arterial than in the venous condition.*

Doubtless the iron, which appears to be an essential element in the blood of almost all animals, is the chief constituent conducing to the magnetic character of the arterial and venous states; but, unquestionably, oxygen or ozone is the matter which, by its presence, operates to convert the inert venous blood corpuscle into the stimulating arterial corpuscle, capable of arousing energy in the tissues. Indeed, it is a well-known physiological fact that the activity of the vital functions is in proportion to the amount of oxygen consumed or used up in the tissues, and that such oxygen has been carried to the tissues by the blood corpuscles.

As pertinent to this portion of the question it may be stated that the coagulation of the blood, which is the spontaneous separation of the blood into a fibrous solid and a liquid (which process is regarded by most persons as a purely vital act), is performed much more rapidly and firmly by arterial than by venous blood, and yet more rapidly and firmly by inflammatory blood; and inasmuch as it is associated with molecular changes, and with changes in the shape and colour of the corpuscles, as well as with the magnetic conditions of the matter, it cannot be separated from the domain of physics.

If this be a correct statement of facts, physical science assures us that it is impossible the blood can move over the tissues in a state of health, and through the lines of terrestrial magnetism with which those tissues are charged, in a degree proportional to their composition and temperature without originating acceleration of the earth's magnetic force in a direction corresponding with

1. The direction and velocity of the blood current.
2. The magnetic state of the blood corpuscles.
3. The temperature of the blood and tissues, and
4. The resistance of each particular tissue.

Consequently each tissue during the circulation of the blood, and the existence of a normal condition of the tissues, must be traversed by energy which is in direct proportion to

1. The direction and velocity of the blood.
2. The magnetic state of the corpuscles.
3. The temperature of the blood and tissues, and
4. The resistance of each particular tissue. And as physiology has determined that the nerve current—by which the functions of life are performed—is in proportion, other things being equal, to the oxygenated state of the arterial blood, there can be no grounds for assuming the existence of some mysterious vital force, the more especially as each act of animal life is capable of being referred to the action of the same physical force under a natural condition of the tissues.

I have stated that the direction of the magnetic energy—or electric current when such is traversing a material substance in a linear direction—will vary with the course of the blood current. And by physical laws such must be the case. But it is equally evident that while we obtain from this source a nerve, muscular, or other current from the heart to the peripheral extremities of the nerves, &c., we have also, by reaction (which always exists) a peripheral current to the heart, and, as the two currents are equal and opposite, a condition of equilibrium is again established the balance of which is as constantly disturbed as it is effected. It is further evident that both these currents are derived from terrestrial magnetism.

By a yet more extended investigation of the same physical laws, we perceive that no local action can take place in the animal economy without a corresponding disturbance of equilibrium, and, therefore, that every such disturbance must be attended with a corresponding manifestation of power; consequently, a beam of light cannot fall upon the retina, a vibration cannot strike the tympanum, a particle of matter cannot impinge upon the nerves of taste or smell, a needle cannot wound a nerve, or the skin of the fingers when in a state of health be brought into contact with matter, without disturbing balance of power and giving rise to a sensation corresponding in degree with the impression made.

Again, the same description of physical force is displayed in the conversion of inorganic matter into the living cells of a living animal. And as this process of formation and growth has been, and I believe still is, considered one of the best proofs that the vital act is not referable to any description of physical force, it will be well to consider the process attentively, as it is known to take place, and then to apply the principle mentioned above.

Dr. Lionel Beale, who has very carefully investigated cell formation microscopically, describes the process as follows:—

"Each (living) spherical particle is free to move in fluid, and the intervals between the particles are occupied by fluid. This fluid contains in solution—

"1. Matter about to become living.

"2. Substances which exert a chemical action, but do not necessarily form a constituent part of the living mass, together with particles which are rejected, and not capable of being animated; and

"3. Substances resulting from the changes ensuing in particles which have arrived at the end of their period of existence, and the compounds formed by the action of oxygen on these.

"There can be no doubt that the smallest particle of living matter is complex. It is impossible to conceive the exist-

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ence of a living particle of any simple substance like iron, oxygen, nitrogen, &c., for living involves changes, in which several different elements take part." And then, with reference to centrifugal action, Dr. Beale states that "movement takes place in the most minute living particles in a direction from centre to circumference, while the inanimate matter which is about to become living passes in the opposite direction; or, in other words, the inanimate matter passes into the centre of a particle which already lives, becomes *living*, and then moves outwards. The flow of the inanimate matter is *centripetal*, and the movement of the living matter is centrifugal. But both these sets of movements are to be accounted for by the centrifugal tendency of the living matter, for it is obvious that as it thus tends to move from a centre, a flow in the opposite direction must be induced. Such a tendency to move from a centre, it would seem, must be due to a force very different from that which controls the movements of inanimate matter. Moreover, while cosmical force influences masses of the largest magnitude and of infinite minuteness, through varying distance, the vital forces can only exert their sway when the distance is infinitely short, and it would seem that this influence can only affect matter which has arrived at the very centre of the living particle."—"Life, Matter, and Mind," p. 110—112.

It appears that Dr. Beale has recognised the similarity between the motion displayed in the formation of a living cell and the cosmical forces which influence masses of the largest magnitude and of infinite minuteness, but fails to perceive, as it would seem, that these living spherules are centres of action which *display energy only in a degree proportionate to their size and material character.*

Unquestionably they are molecules of matter of a compound character, but they are permeated throughout with energy which is common to them and the surrounding matter, which energy has a cosmical origin. Nevertheless, that force which can be estimated at many quadrillions of tons when exercised upon the sunward surface of the earth, when diffused over the mass of the earth can only affect the molecules in proportion to the material capacity of each to retain it; and then the force is so marvellously balanced as action and reaction that particles, when subjected to its influence and free to move, as I have demonstrated by what I will call the shot experiment, are kept rotating upon their axes by the two forces, and the resulting phenomena must be regulated by the degree of energy each molecule receives, plus the resistance each offers to the action of the force. It is, therefore, evident that as the vital force is a molecular force, the centrifugal force it displays must be determined (other things being equal) by the composition of the material particle.

But whether the cosmical nature of the force is accepted or not, it is manifest—

1. That some invisible mechanical force must be operating upon the living spherule to give it centrifugal motion.
2. That this manifestation of force, energy, or power has been impressed upon the anatomical unit, for spontaneous movement has apparently been imparted to the matter.
3. That this motion is intimately associated with the material composition of the unit.

We next perceive that the radius to which the energy of the revolving matter is capable of throwing off the matter which has been conveyed to the centre must define the boundary of the cell wall, and as the matter cannot be thrown off until it has been conveyed to the centre, it is evident that both centrifugal and centripetal forces are dependent upon the rotation of the anatomical unit; and the cause of this motion is at once explained by reference to the shot experiment.

By another application of physical laws we ascertain another very important fact, viz., that purity of material is most essential to the proper fabrication of a healthy cell; for as the integrity of the healthy cell must depend upon the description of motion to which the matter is subjected—that is, to the manner in which the molecules are arranged and deposited in the cell wall,—and as the character of the motion must depend, other things being equal, upon the nature of the matter, every form of matter giving a particular direction to force, so the cell formed must be modified in structure and in energy by its material composition.

One of the strongest evidences that can be obtained of the action of this principle is found in the physical differences of shape and size which exist in the blood corpuscles of the different forms of animals. So far as has been ascertained—and much has been done in this direction by Hewson, Gulliver, and others—the shape and size of these particles differs in every form of animal, certainly in every species; the cause of which is readily understood if the force is the same, and the matter of which the blood corpuscles are composed varies in character or in the proportion in which the elements are combined. For the rotating matter which is being moulded into shape under the influence of a force—the energy of which is proportioned to the quantity and character of matter in motion—is bound to be modified in shape and other physical characteristics by the inclination which its molecules—possibly its atoms—give to the force.

The cause of different kinds of germinal matter having the power of rearranging the elements of the very same pabulum is also clearly traceable to the same cause, and we can thus perceive that a degraded condition of the pabulum is capable of leading, upon the same principle, to a modified condition of the cells, both as pertains to the formation of the tissues as well as to the mode in which these cells act as distributors of energy.

With reference to the influence which *gravitation* exercises upon the growth of the tree, and which has a very important bearing upon this inquiry—at any rate, as far as pertains to vegetable life—I find Dr. Beale has considered this question also, for he says: "Neither can it be said that life works *with* physical and chemical forces, for there is no evidence that this is so. On the other hand, it is quite certain that life overcomes, in some remarkable and unknown manner, the influence of physical forces and chemical affinities. Does the tree grow away from the earth, or its roots into it, in obedience to the laws of gravitation? Are certain things taken up from the soil, and others rejected, or do the leaf cells tear away from carbonic acid its carbon, and drive off its oxygen, by reason of chemical affinity?" *Idem*, 117.

With reference to these questions it will, I think, be seen that life, like every other correlation of force, has a special mode peculiar to itself of giving acceleration to the earth's energy, and so of re-directing or adapting the universal force to its own requirements; for so long as every form of matter is pervaded with magnetic force, acquired as it is by the motion of the earth through the force of the sun; so long as the laws of motion exist, especially that of action and reaction, so long in the vegetable kingdom of nature must the radicle be driven into the earth by the energy of the sun, and the plumule ascend out of the earth by the energy of the earth. Thus long, also, must the leaf cell possess the property of fixing the carbon and driving off the oxygen, for the carbonaceous element existing in and forming the basis of the vegetable kingdom of nature must be regarded as representative of that element which is driven into the mass of the earth by the force of the sun; whilst the oxygen which is taken up by the rootlets in the form of water is indicative of that energy which is due to reaction or the earth's motion. Consequently, in both kingdoms of nature the germinal matter selects matter most nearly allied to itself, and whilst we see carbon absorbed and oxygen repelled by the leaf of the plant, we find oxygen taken up by the animal, and carbon repelled, and yet vital motion in each intimately associated with, if not absolutely due to, the presence of oxygen. For instance, the roots of the plant are water-seekers, which water is composed by atomic weight—weight has a most important bearing on this inquiry—of eight parts of oxygen and one of hydrogen, and the sap is formed principally of water. This water, as circulating sap, is bound to be polarised throughout, for it is a transmitter of currents of electricity; and therefore the motion of the oxygen, as oxygen, must be appreciable to the molecules of matter over which it passes. Again, in the animal kingdom of nature, it matters not whether the supply of oxygen is obtained from the atmosphere or the waters, oxygen is still the principle

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which is utilised for the purpose of sustaining vitality. We must, however, always remember that all vegetable formations are more or less directly associated with the mass of the earth, out of which they *grow*, whilst animal life has almost universally a separate existence, and evolves, as it were, its own powers; for although both these kingdoms of nature are pervaded with magnetic force, the special acceleration of motion, which pertains to vital action, is much more marked in the animal than in the vegetable kingdom; and, indeed, it would appear that we should be justified in regarding all vegetable formations as a means of radiating the earth's magnetic force to the atmosphere, and of preparing in other ways a pabulum capable, under the influence of the same energy, of sustaining life even in the highest forms of the animal world.

But it is important to this great question, viz., the nature of animal life, that the term *vital* should not be misapplied. And with reference to this point, I find that Dr. Beale remarks:—"I regard '*vitality*' as a power of a peculiar kind, exhibiting no analogy whatever to any known forces. It cannot be a *property* of matter, because it is in all respects essentially different in its actions from all acknowledged properties of matter. The vital property belongs to a different category altogether." *Idem*, p. 103.

In the main I quite agree with Dr. Beale in his view that vitality is *not a property* of matter. Nevertheless, I find it difficult to define exactly what is and what is not a property of matter. The statement certainly needs some qualification. For instance, it is evident

1. That animal life cannot exist without a material body.
2. That the material body is the medium of manifesting all the phenomena pertaining to animal life.
3. That all vital phenomena are in some way due to the mode in which particular forms of matter have been associated and are caused to act and re-act upon each other.

But it is equally true,

1st. That the material body without the vital power would be simply an inert collection of matter.

2nd. That the material tissues are only the agents by which the phenomena of life are manifested.

3rd. That the vital power is derived from a source external to the body; and that the body in displaying the phenomena of life only acts at the most in accordance with the third law of motion, by manifesting a reaction from within, in proportion to the action from without.

We are, therefore, justified in asserting that, inasmuch as the power matter possesses to display vital phenomena depends,

1st. Upon external impressed force,

2nd. Upon a law operating equally upon all matter by which force is transmitted in lines which vary with the composition of the matter, therefore the complicated mechanism of an animal body is not due to a property of matter, but to a *definite combination of atoms adjusted in regular order, with the object of eliciting a certain set of phenomena, corresponding in each form of animal life with the special arrangement of the atoms.*

But in adopting this view it is obvious that vital phenomena can no more be removed from the properties of matter than any other phenomena with which we are acquainted in the inanimate kingdom of nature; all, indeed, belong to the same category, for *every* natural phenomenon which comes under our observation is the result of similar impressed force; that is, of force impressed upon matter with the object of promoting a certain effect, in which design is as much marked in the inanimate world as it is in any form of animal life.

In my previous letters I have traced this principle of action from the atom to its supposed source, and have pointed out that the theory put forward a few years since by the late Professor Clerk Maxwell is, probably, correct. That theory supposes that matter has assumed different forms or conditions owing to the mode in which its atoms were primarily arranged and combined, and we can readily understand that if each material atom has a directive influence upon force—which it is at all times the medium of transmitting—that the physical characteristics of the matter must vary with the manner in which those atoms have been adapted to each other.

In my present letter I believe I have shown the mode in which the animate kingdom of nature is subject to the same law, so that every modification of that arrangement which was impressed upon the elementary atoms or units when they were first combined and formed into a living cell is bound to be followed by a corresponding change in the phenomena elicited. If this principle be correct we can trace almost every form of disorder and disease, every malformation of body, and every mental misdirection to which the human family is prone, to a departure from that material condition which was originally impressed.

I cannot conclude these papers without expressing my great regret if I have appeared in any manner to dogmatise. Such has been the reverse of my wish. To the best of my judgment I have applied the laws of motion to an invisible force, guided by a close scrutiny of artificial magnetism as it occurs in bar magnets, and it has appeared to me that those laws of motion are bound to hold equally good under the circumstances to which I have referred in the foregoing papers as they would were we dealing with pure mechanics.—Yours, &c., R. C. SHETTLE.

Reading, Sept. 28, 1882.

POST OFFICE MANAGEMENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On one of the closing days of last Session, Mr. Fawcett expressed an opinion to the effect that surplus Post Office revenue should be applied to improving the service. This is good theory, but in practice there is no surplus, the Treasury keeping a tight hand on all supplies, without enquiring where they come from. But the Post Office is an exceptional branch of Government, claiming a monopoly of an important part of the nation's business, and that business should not be restricted because an Egyptian colonel or a savage chief causes us to have to spend two or three millions on a "little war." As a compromise between the theorists who hold that no profit should be made by the Post Office and the present practice, let all net revenue above 1s. 6d. per head be retained by the Post Office for needful improvements, of course under Treasury supervision as to details. The net revenue per head before penny postage was 1s. 2d., it is now 1s. 7d.; average for last ten years, 1s. 3d. There is no fear of the rate decreasing, so that the Treasury would be assured of a certain sum yearly, and, on the other hand, there is not much danger of the surplus being so large as to make the service too perfect.

I need scarcely enter into details of how the money may be applied. The question of the rural districts was specially mentioned by Mr. Fawcett. There are also the Irish and Scotch mail services needing improvement, and innumerable local matters, from a new office for Liverpool, to a pillar box for Pond-on-the-Beach.

Telegraphs occupy rather a different position to postal work proper, which is what I have above referred to. They have a capital account of above £10,000,000, the interest of which is set off against receipts, when reference is made to the profits arising from them. Has not the time come for an increase of this capital account, in order to put the department on a strong footing, which it cannot be said to have had, owing to the extravagant sum paid to companies in the first instance? This is needed for several reasons. Mr. Fawcett's advisers calculate that a loss of £200,000 would occur the first year following the introduction of sixpenny telegrams, gradually becoming less till the wires would again become profitable. Many competent judges, however, hold that such a loss is imaginary, and that the increase of work would be so great as to necessitate some such plan as I mention. Of course, the expense of providing the additional apparatus might be thrown on the current year, but when we find Mr. Fawcett declaring himself unable to face the loss of £200,000, the plan named seems the only way by which cheaper rates can be obtained. By it, also, we could provide for underground trunk lines, extensions to country places, and, perhaps, pneumatic apparatus for the larger towns.

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Owing to the introduction of telephones, a large amount of business is being taken from the Postal Telegraphs, and Mr. Fawcett has expressed his anxiety to reach the classes who have not hitherto made much use of the telegraph. Would it not be advisable, in case a reduction takes place, to begin at lower than sixpence for ten words? Fourpence for one word, and a penny for every additional three, would cover expenses. Porterage charges might also be reduced. But I think enough has been said, and hope it will prove useful.—Yours, &c. O. P. G.

P.S.—Since writing, I see the French Post Office has been granted £2,000,000 for underground wires.

CITY AND GUILDS EXAMINATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The examination questions on "Electrical Engineering" in connection with the City and Guilds of London cover such a large electrical field and involve so many important principles that I take this liberty to ask you to have the whole of the questions set last May answered in your excellent journal—that is, if you can arrange with some able person or persons to undertake the task.

I make this request because I think two or three columns each week devoted to the questions until they were exhausted would be a boon to many of your young subscribers. I know for a fact that they would be to many in this town, and I believe they would not be devoid of interest and instruction to even veteran electricians.

Hoping you will be able to see your way clear to comply with above request.—Yours, &c., J. G.

68, Woodhouse-lane, Wigan, Oct. 8, 1882.

[Are a sufficient number of our readers interested in this matter is the question we must have answered before deciding to occupy our space with such solutions. We shall be glad to hear from any one who desires to see J. G.'s suggestion carried out.—ED. *E.*]

PROFESSOR FORBES'S ARC LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Professor Forbes having made his lamp the subject of a communication to the British Association, it may not be out of place for me to say that the principle was suggested in the Clelland Prize Essay, Glasgow University, 1879. The idea was very favourably received by Sir Wm. Thomson, but was, unfortunately, laid aside until a more convenient time, which did not present itself until a few weeks ago, when I took it up and worked it into a somewhat more perfect form than that described by Professor Forbes.—Yours, &c.,

ARCHIBALD C. ELLIOTT.

71, Queen-street, E.C., Oct. 7, 1882.

[Mr. Elliott does not say in what respect his design is more perfect than that of Professor Forbes. Will he send diagrams with explanations, so that readers may judge for themselves.—ED. *E.*]

JOSEPH LIOUVILLE.

The Academy of Sciences has, within the last few days, says *L'Electricité*, lost one of its most celebrated members, M. Joseph Liouville, the intimate friend and confidant of Francois Arago. We are not concerned at present with describing here the part played by the illustrious dead in science and politics, but it is impossible for us to pass over an incident in his long and glorious career, which has been overlooked in the official biography, and which we hope may not be lost to posterity.

If the tables of the great scientific *répertoire* of the Royal Society of London be consulted, the name of Liouville will be found to be mentioned more than 200 times in connection with the demonstration of theories of grand analysis, ornamenting the forty volumes of the mathematical paper of which he took the editorship on the death of Gergonne. The first of these *mémoires* according to date, that which was produced when Joseph Liouville was yet a pupil at the School of Civil Engineering, treated of electricity. It has been published at page 411 of the 41st volume of the first series of the *Annales de Chimie et de Physique*, then under the management of Gay-Lussac and Arago. It formed part of an extended *mémoire* presented to the Academy of Sciences in the course of the month of June, 1878.

Under the modest title of "Demonstration of a Theorem in Dynamic Electricity" Joseph Liouville established the legitimacy of the hypothesis common to Ampère and Savary. Proceeding by simple experiments, he showed in an elementary way that the mutual action of two voltaic elements is always directed in the line which connects the two middle points. It is a theorem as fundamental in electro-dynamics as the postulate of Euclid in the theory of parallels. The method adopted by Liouville is simple enough to enable us to give some idea of it. It is deduced by the reasoning, supported by some characteristic experiments of Ampère, on the fact ascertained by Oersted—that an electric current has no force of action, and that its mode of exerting its power is the same in all azimuths. Joseph Liouville began his demonstration by having recourse to the argument of symmetry, and by this means he determined it most clearly. Now if two currents, both supposed to be equal, situated in a straight line, and in the direction of their prolongation, do not act according to their common direction, but if their mutual action is oblique to this line, and we take, by hypothesis, another, any line situated on the two surfaces of the right cone of which the angle at the centre is that of the two lines will agree equally, and the action of the two elements will be undeterminate. From this case we easily pass to that of two currents which, placed in the same relative position, are in a given commensurate ratio; then we pass to the limiting cases of incommensurate quantities.

This done, Joseph Liouville examined the case of two equal currents situated perpendicularly on the straight line which connects their central points, and which bisects them equally. The experiment of Ampère proves that the direction (*sens*) of these two currents can be changed without altering the effect, and there is a perfect symmetry in their action. In consequence it can only be exerted in the median line. These two elementary cases having been established for certain intensities of current, the parallelogram of currents allowed the demonstration to be completed with the greatest simplicity, of another experimental fact established by Ampère. It is this combination of reasoning and observation which is true mathematical physics, and the analytical vagaries which please some foggy and second-rate minds does not merit in any way such an honourable qualification.

Arago expressed himself in flattering terms on the subject of this *mémoire*. "The experiments of Ampère from their first appearance were the objects of the severe criticisms which I have noticed, and shortly after of universal admiration. As to the complicated and deep calculations, the delicate theoretical deductions of which I have tried to make you understand the wide bearing, they should only be judged by competent and enlightened geometricians. Now, is it correct to say that French geometricians were wanting in relation to our illustrious *confrère*, when, shortly after the birth of electro-dynamics, we find M. Savary completing a very important point in this theory, and when we see M. Joseph Liouville devoting himself to simplifying its foundations and rendering them stronger?"

We should add, to complete the preceding, that M. Joseph Liouville did not lose sight of the beautiful demonstration by which he began his scientific career. In fact, as soon as Léon Foucault had experimentally demonstrated the independence of the plane of oscillation of a pendulum and the diurnal movement of the earth, M. Liouville discovered an ingenious demonstration which Arago has preserved on page 47 of the third volume of his "Astronomie Populaire" and in which the same method was employed.

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THE ELECTRICIAN.

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ANOTHER BOOM.

"John Smith was a business man—able and energetic, and he was the promoter of companies. The said John Smith knew as well as any man how long with safety to his banking interests he could attach himself to any scheme, and the right moment to leave it in order to enter new fields."

Thus, allegorically, in the days of Addison and Steele would public attention be directed to public evils. Of course the allegory ended with "Lo! I awoke, and behold it was a dream." It is hardly possible to conceive a more delicate way of telling the world of its little sins, or cautioning it against the wiles of those whose sole aim is to devour all they can. The exigencies of life nowadays are such that few writers can find time to copy the quaint conceit of these old authors, and hence, when attention has to be directed towards any particular object, it is necessary to call the spade a spade.

Some of our correspondents have during the past week or so been honestly endeavouring to arrive at a right conclusion as to the meaning of the numerous letters and articles in *The Times* and *Daily News*, and failing this, have asked us what the correspondence means? He would be bold who answered that both *The Times* and *Daily News* thoroughly understood what was intended in the correspondence they have made public. There is, as is well known, no one so blind as he who will not see.

Once upon a time a Cambridge examination paper contained the question—Why would a pin not stand upon its point? Three clauses supplied the answer, and three similar clauses will supply an answer to many questions concerning electrical companies and electrical apparatus. The last clause of the well-known answer reads as follows:—"It will stand on its point if you stick it in," and so the *Daily News* thinks that its article on the "Cost of Electric Lighting," of July 6, will go down if only the long bow is drawn strong enough. Fancy a paper of its standing basing comparative calculations upon figures derived from a trade price list! A more astounding article than the one we refer to was, probably, never published in any paper. With the exception of giving an estimate evidently prepared from a price list, and referring to a huge machine which is, we believe, not yet made, even if the working drawings are complete, the results from which are estimated by those from a smaller machine not yet known to the public—with this exception, we say, the whole article is as devoid of nous, and as full of indications of ignorance of the whole subject as the sea is full of water. These are the kind of teachers permitted to amuse the English public, and we certainly should not give a word of warning were it not that the interests of electric lighting suffer so much from such charlatanism. There is no getting at the readers of these articles to disabuse their minds of the false teaching. The harm is done, for such papers have not the grace, even if they have the ability, to acknowledge an error. Any indication of fallibility would be ruinous—and yet people speak fairly, and outwardly say they prefer honesty. We should like to ask one question. The article referred to says, "Without pretending to have pitched upon the very best system, &c." Our question is, what does the writer know of the system he discusses?

The cost of electric lighting is not to be obtained from a price list nor from an estimate. It must be obtained from complete installations that have been at work months or years. The promoters of companies are not the best guides of the public, nor are letters and articles containing so palpable a moral as those we have alluded to. The cost of the electric light in one place is no criterion of its cost in another, nor can the cost of an installation be rigidly compared with the cost of gas lighting in a far-off district. Gas does not cost the same in some places in Yorkshire and Lancashire as it does in London, New York, or the Cape of Good Hope, and while the cost of the electric light can be made on paper to be less than the cost of gas with gas at 4s. per thousand, it may be made much more when the calculations are made by those interested in gas, taking gas at 2s. 6d. a thousand, and there seems to be no reason given by the writers of these letters why the one price should be taken more than the other. We have before us a series of figures—calculated by a gentleman who, perhaps, better than any other man in England, knows the actual cost of electrical lighting—being

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the comparison between the cost of gas and electricity in London, in a district where gas is 3s. 2d. per 1,000ft., the result being favourable to electricity; yet many of these figures are, necessarily, conjectural.

We shall refer directly to but one more paragraph in this recent correspondence, which shows how difficult it is to teach correctly. Mr. Pertwee, the manager of an electric light company, writing evidently in favour of the new machine, says (*Times*, Oct. 2):—"From careful inquiries which I have made I find that machines up to the present time supplied for incandescent work yield as follow: Brush four lights; Siemens, at the Savoy Theatre, eight lights; Edison, at the Holborn installation, ten lights; Ferranti, at the trial installation, eleven lights per horse-power." Does Mr. Pertwee quite understand what he writes about? The lights he refers to, are they the same or are they different? We believe they are different, and now to show the absurdity of such a sentence as an argument. The horse-power absorbed by each lamp is expressed by the formula $\frac{C\,E}{746}$, when C is given in amperes and E in volts. Taking the Edison A lamps mentioned in our article on the Munich Exhibition, having a resistance of 140 ohms, and requiring an E.M.F. of 103 volts, it will be found impossible for a Ferranti or any other machine to run eleven of these lamps per horse-power. Each lamp absorbs about $\frac{75}{746}$ of a horse-power, so that with perfect transmutation of the indicated horse-power only about ten lamps, perhaps, could be obtained. It is, then, no proof of the goodness or badness of a machine to say it supplies two or ten or two hundred lamps per horse-power. We must know something more than the number of lamps. We want to know the kind of lamp, its resistance, the E.M.F. required, and the normal candle-power given. The Brush machine might, for all Mr. Pertwee explains, supply four lamps of 100 candles each per horse-power. We do know that the Holborn lamps and the Savoy lamps are widely different. From Mr. Pertwee's letter the inference is that Siemens's at the Savoy is worse than Edison's at Holborn. Taking his own figures, ten of the Holborn lights at 16 candles give a total of 160 candles per horse-power; while eight of the Savoy lights at 20 candles give also a total of 160 candles per horse-power. Now, suppose the eleven lights for the Ferranti were of 8 candle-power, *i.e.*, the B Edison lamp, the gross total is 88 candles per horse-power.

We have not referred to this subject because we wish to exalt one machine over another. We have absolutely no leanings towards this or that maker. We have spoken in answer to correspondents, and to do our duty towards the public. The wilful suppression of the information which will enable the reader to judge of the comparative value of any statement is hard to understand, hence we must consider the articles and letters referred to as being the productions of interested men, eager to extend their business, but utterly ignorant of the first principles of electric lighting.

THE FEMALE TELEGRAPHIST AGAIN.

The competition of eight hundred female candidates for thirty vacancies in the postal telegraph service a week or two ago has furnished the usual text for a multitude of newspaper sermons, and a more than usual amount of ridiculous misrepresentation. Social scientists draw from it a moral that the relations of the sexes are very unsatisfactory—a matter upon which, as we are not acquainted with the domestic affairs of social scientists, we will not presume to argue. Philanthropists call upon us to redouble our efforts to find employment for the seven hundred and seventy maidens whom the Civil Service Commissioners have cast destitute upon the world—a call which we shall not respond to, for our part, as we decline to draw such big inferences from facts so very insignificant. Again, the Postmaster-General, or the Postmistress-General, for we are left in doubt as to which is intended, is invited to find room in the Post Office for our surplus population of spinsters; and, again, we dispute the whole proposition. A surplus, in the sense of there being too many, certainly does not exist; and even if it did, the obligation to find room for redundant females in a public department is by no means self-evident. Lastly, we demur to the process of finding room, if it means, as we suspect it does, making room by shouldering out the other sex. That process is obviously calculated to enlarge the profession of spinsters by impoverishing the single men. This may suit the celibate sisterhood, but the involuntary bachelor will probably have something to say to it—something to the effect that If she will not marry me she shall not ruin me.

Most of the reflections drawn from this recent competitive examination are based on the very poor wages offered to the candidates—only 10s. a week, and yet there were 800 applicants! The actual facts are these. The 800 forlorn spinsters were in reality girls between the ages of fourteen and eighteen—at least so ran the advertisement—the majority being, we may assume, about sixteen years of age; and the examination they had to undergo was such as any child of thirteen years might easily have passed. So much for the persons and qualifications over which there has been this excess of gush. Now as to the wages. Ten shillings a week is not bad pay for a girl of fourteen, or of even eighteen. It is as much as many upgrown men and women can earn who are far more useful members of society, though, perhaps, they cannot write so good a hand. But 10s. is only the beginning wages of these telegraph girls, who can count upon 25s. or 30s. a week in the course of a few years' service, and the prospect of rising to positions more highly remunerative. For persons whose education is not superior, or at all events is not required to be superior, to that of a village schoolgirl, such a career on such easy terms is a specially attractive one, and to our thinking would if more widely advertised attract as many thousand candidates as now come in their hundreds. The result proves absolutely nothing in respect to the matter in which the shrieking sisterhood and their feminine male backers are interested. All that it proves is that the rising generation of girls prefer not to soil their hands with hard work, and that their parents eagerly snatch at a substantial increase to the family resources obtained in so "respectable" a way.

A GUIDE TO PRACTICE IN THE SUBMARINE CABLE TESTING ROOM.

IV.

The use of the electrometer as employed for a test, which a beginner is easily taught to master, may very properly be introduced at this point. The practical execution of this test is very simple, and it is customary to entrust it to a youth whose intelligence need not go beyond the performance of a mechanical duty.

This instrument enables us to measure the difference of potential between the electrical charges of any two bodies subjected to electrical influence, or between the charge at one time and that at any other during its existence. To explain how this condition bears upon our subject a word or two is necessary on the question, "What constitutes an electrically good or bad cable?" Briefly, then, submarine telegraph

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cables are made in accordance with a specification which sets forth the amount of conductive resistance per knot, or nautical mile, for its copper conductor; the amount per knot also of its electrostatic capacity, which means, generally speaking, its capacity for retaining a definite electrical charge; and, thirdly, the required insulation resistance, which is a quality representing its ability to resist the escape of an electrical charge through the insulating cover. The second and third of these qualities may appear at first sight identical, but they are not so, except in relation to the fact that the capacity measures the conditions for accurately determining the insulation resistance. If, for instance, a cable were not fully charged, a correct test of this resistance could not be obtained. We may say that a cable can receive or accumulate such and such a charge, and it resists its escape with such and such retaining force. A bowl will contain so much water and no more, and this will flow out according to the facilities provided for it, that is to say, as we overcome the restraining power of the side or bottom of the vessel. The three conditions just named are all intimately related to each other, and are all determined with reference to the signalling qualities of the cable. They depend upon the relative thickness of the conductor and the insulating cover, or dielectric, as it is technically termed, and also on their purity and excellence. A certain weight for each nautical mile of both copper and gutta percha (or india rubber, if this be the dielectric employed) is decided

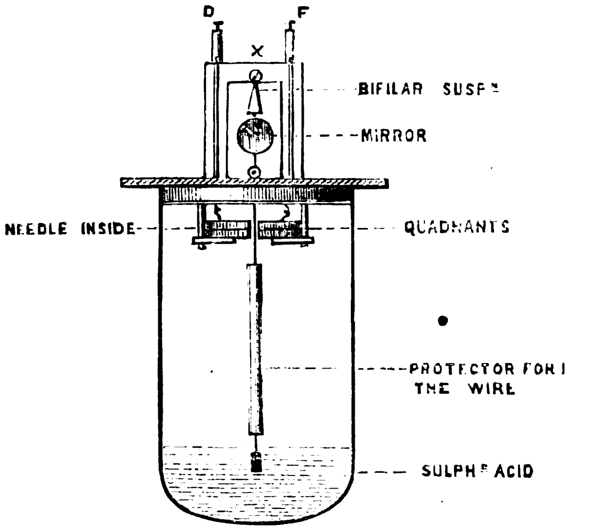

FIG. 6.—Skeleton View of the Quadrant Electrometer.

on, and the core thus constituted is distinguished as to its description as one of such and such a ratio of the two constituents; for example, as a core of $\frac{400}{400}$, or $\frac{107}{170}$, &c., the upper value in the fraction referring to the weight per knot of copper in pounds, and the lower one to the weight per knot of gutta percha or other dielectric in pounds also.

A cable, therefore, is considered good when the resistance of its conductor does *not exceed* the stipulated amount, and when the insulating resistance of its dielectric is *not less* than the specification allows. It is seen from this that resistance in the conductor is a failing, regarded as a quality, but is a good feature in the gutta-percha covering. We look for a low value for the first, but a high value for the latter.

The electrometer is used for a variety of purposes in the testing room, but we are only at present concerned with its employment for keeping a watch on the electrical condition of the cables during manufacture. The insulation being so very important a quality, it is desirable to be assured that it is always good, and this we are enabled to achieve by connecting the cables to the electrometer, and so maintaining a continuous examination of their condition. The test does not generally aim at determining particular values for the insulating power, but shows us at any or every moment whether it is as good as it ought to be. The regular tests for values, as those of the copper resistance, the electrostatic capacity, and the insulation resistance are usually taken three times during 24 hours, and if the electrical condition of the cables were unwatched in the intervals it would be quite possible for a fault to occur which would not be discovered until some hours after actually breaking out. A cable machine will make, that is, will sheathe from three to three and a half to four, or even five knots in 24 hours; so that if a fault occurred six hours before it could be observed, there would be, perhaps, a knot length of it coiled away in the tank which would have to be "turned over" or coiled out again, the machine standing still until the fault were cut out. This can scarcely ever happen if the various cables or "machines," technically speaking, are under the charge, as it were, of the electrometer. This instrument tells us, as plainly as if it could speak, when anything goes wrong with their electrical condition. It should be said, in fairness to all submarine cable manufacturers, that what are called *electrical* faults occur very rarely indeed. A fault nearly always turns out to be *mechanical*, that is to say, it is caused by some injury from without, and is either accidentally, negligently, or wilfully brought about.

We must say a few words in describing the electrometer, though here again the text books should be consulted by the learner. He may, however, be taught to use the instrument for the purpose we have immediately in view without knowing anything of its theory or construction. The slight sketch given of it in this place (see Fig. 6) is intended as a kind

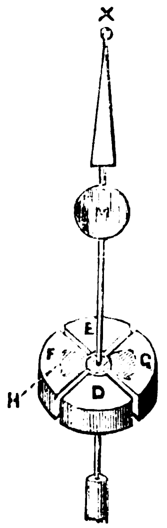

FIG. 7.—Suspended Mirror and Aluminium Needle.

of skeleton view of those working parts more directly concerned in producing the effects which the operator has to watch.

The student will see on the table appropriated to this test a scale placed opposite the instrument, and will notice that a spot of light is reflected on it, the arrangement being so far similar to that of the galvanometer and scale in the bridge test. In both cases the light is reflected from a tiny mirror in the instrument, but in that now being discussed there is no magnet fastened to it. The mirror in the galvanometer is moved by the passage of a current through the coils round it acting on the magnet; but in the electrometer there are no coils, and the effect is produced by a difference of electrical charge between the two pairs of quadrants D E and F G influencing the aluminium needle H suspended between them. A wire connects D to E, and another joins F to G, thus making two pairs. The needle being connected by a rigid platinum wire to the mirror and both hanging from the point of suspension X, when the former moves the latter moves with it, and a deflection on the scale is the result. (See Fleeming Jenkin's "Electricity and Magnetism" and Kempe's "Handbook of Electrical Testing" for full description.)

The two figures 6 and 7 are merely arbitrary as to dimensions, the object being only to let the learner see at once the principle of the instrument. There are other parts which he will have to know and use in the simple test he is entering

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on, but we have left them to the next number, when they will appear at the proper place. The points marked D and F in Fig. 6 are the terminals for connecting anything to either quadrant.

We now proceed to explain as briefly as possible the principle on which the continuous employment of the electrometer is based.

If a battery be applied to one end of a cable and the other end be connected to earth, there will be a current which passes through constantly, and the cable is not technically said to be charged; but if the further end were insulated (or left free in air) a charge would be the result. A quantity of electricity would fill the cable, so to speak, and it would be charged to a certain potential, depending generally on the conditions stated above, remaining charged till the battery were taken off. When this is done, the cable remaining insulated, the charge will escape, gradually falling until all were gone. It would be considered a good feature in it if the charge fell regularly and slowly, and any means by which this fall can be watched and measured is of the greatest value.

Every submarine telegraph cable can contain a charge of a definite amount according to its *capacity*, and when in a position to part with its charge, the ends being insulated, it leaks or passes off at a regular and well understood rate. By way of illustration we will suppose we have a vessel filled with water, which is to flow out through a pipe of a certain bore; we want to know if the vessel loses its contents faster than it ought to do through this pipe. For this purpose we must know how much the vessel really holds, and how much escapes in a given time. If it were made of glass the lowering of the level of water could be observed, and if this fell quicker than the previously ascertained conditions declared it ought to have done, we should know that there was something wrong. Supposing the pipe were not in fault there must be some other cause of leakage. In some degree after this illustration the electrometer acts as a glass through which we can observe the fall of the charge in the cable, and know, therefore, whether it continues constant to the standard of excellence which is claimed for it. Whilst this analogy can be made useful in a general way, it must not be followed too far, for water escaping through a pipe is influenced by other laws than those which govern the leakage of a charge from a telegraph cable. However, we are not now about to use the electrometer for determining any special values, but merely to see whether the leakage is greater than it ought to be in a given period. If we can establish a mark-point showing us when a cable is fully charged, and, following its fall, have another point marking the proportion in which, or the limit to which it ought to have fallen in the given period, we can tell whether it shows the required insulating quality.

The explanation above of the reason for the deflection seen on the scale may be supplemented and made clearer by a few additional hints. If a pith ball were suspended (from an insulated point) between two brass plates, their supports also insulated, it would remain quiet, having no tendency to one side or the other. But if we charge one of the plates, say, from an electrical machine, the ball would swing towards it. If both plates were equally charged, the ball would be in a condition of equilibrium; and if one plate had a higher charge than the other there would be attraction on that side. Now, the aluminium needle in the electrometer corresponds to the pith ball, and is suspended between two brass plates, that is to say, two pairs of brass plates, the difference being that, as it is fixed at its centre to a rigid wire, its movement will be as on a pivot. The mirror partakes of its movement, and both will move slowly or otherwise, according to the difference at any moment of the electric potential or amount of charge of the opposed pairs of quadrants. But the aluminium needle must be something more to the quadrants than the pith ball was to the plates. It also must be charged, and if possible maintained at a steady potential. The correctness of the indications depends upon the potential of the needle being constant, at any rate for purposes of accurate comparison. Means are provided for this, which, together with much other interesting matter, we must leave the learner to study by the aid of the works previously recommended.

The scale for observing deflections is not graduated in the same way as that used with the galvanometer. The latter has the zero in the centre, and the figures increase on each side to 460 or so. The scale for the electrometer has the zero at one end, and increases all the way to the other end. The connections and details of the operation will be given in the next number.

ON THE ALTERATION IN THE DIMENSION OF THE MAGNETIC METALS PRODUCED BY THE ACT OF MAGNETISATION.*

BY W. F. BARRETT, F.R.S.E., M.R.I.A., &c., PROFESSOR OF PHYSICS IN THE ROYAL COLLEGE OF SCIENCE, DUBLIN.

Dr. Joule long since discovered that when a bar of iron was magnetised by an electric current traversing a helix around the bar, an elongation of the bar took place equal to about $\frac{1}{200000}$ of its length for the maximum magnetisation. The bar used by Joule was a yard long, and a quarter of an inch square, and it lengthened $\frac{1}{5772}$ of an inch, or calling the length of the unmagnetised bar unity, when magnetised it became 1·00000481, which would correspond to the elongation that would be produced by an elevation of temperature of two-fifths of a degree centigrade. In subsequent investigations, published in 1847, Joule found the elongation of the iron to be nearly proportional to the square of the actual magnetisation. By placing the bar of iron in a vessel of water, stopped with a capillary tube, he found the volume of the iron was not augmented by the magnetisation, and hence concluded that its transverse dimensions contracted. Under longitudinal pressure the rod still elongated when magnetised, but under longitudinal tension the rod shortened when magnetised when the tension exceeded 600lb. on a rod a quarter of an inch diameter. Soft steel behaved like iron, but *hard steel*, under all circumstances, Joule found to shorten when magnetised, only, however, so long as the current was passing, no alteration of length being due to the permanent magnetisation of the steel.

In 1873, Professor Mayer, of Hoboken, U.S.A., by means of an improved and delicate apparatus, measured with great accuracy the change in dimensions that occurred. Mayer found that a rod of iron five feet long, when magnetised to saturation, lengthened 0·00022 ($\frac{1}{5000}$) of an inch, or a coefficient of 0·0000366 ($\frac{1}{277000}$) of its length. Joule's observation of the shortening of hard steel was confirmed by Mayer, but a different result to Joule's was obtained with soft steel. When it was subject to no tensile strain Mayer found soft steel to suffer a contraction of about one-third of the elongation produced in iron for every current after the first, the bar lengthening when the current ceased. Singularly, the first effect of the current was to produce an elongation of the soft steel.

In the same year, 1873, I made a series of experiments on the change in dimensions of iron, nickel, and cobalt when subject to magnetisation, and in that year I discovered that nickel suffered a scarcely perceptible contraction in length when the magnetising current passed, but that cobalt, like iron, invariably elongated.† The result surprised me very much, as the magnetic properties of nickel resemble iron, whilst cobalt has a high degree of coercive force, and so far, therefore, resembles steel. I was indebted to Messrs. Johnson and Matthey, the eminent metallurgists, for the very fine specimens of nickel and cobalt which I employed, which, however, may, and probably do, contain more or less carbon as an impurity, and, therefore, resemble cast iron. Mr. Gore, F.R.S., also lent me a fine bar of nickel, and with it similar results have been obtained.

The apparatus I first employed was made for me by Mr. Yeates, of Dublin. It is shown in Fig. 1. The bar to be examined, I I, is mounted on supports, and presses against

* Paper read at the Southampton meeting of the British Association, with additions by the Author.

† *Philosophical Magazine*, January, 1874.

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the end of a system of levers shown enlarged in Fig. 2. To the long arm of the lever D is fastened a silk thread, which passes round a grooved wheel, giving a motion of rotation to the mirror *m*, from which a distant scale is reflected to an observing telescope furnished with cross wires. A light brass spring, *s*, enables the position of the mirror to be adjusted, and the counterpoise weight, *w*, which replaced the

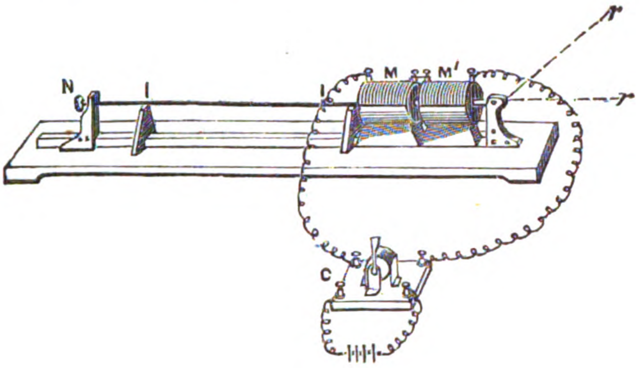

Fig. 1.

reaction spring first used, brings back the levers when the thrust of the experimental bar on P is released. The magnetising helices, M M[1], Fig. 1, could be shifted to any part of the bar I, the commutator C is placed on a different support to the apparatus, and finally a micrometer screw, N, reading to $\frac{1}{10000}$th of an inch, abuts against the end of the bar.

With this apparatus the following results, the means of very many observations, are copied from my note book for

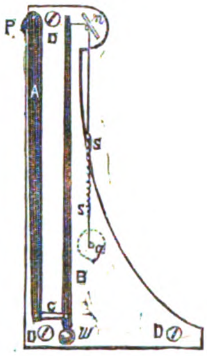

Fig. 2.

September 9, 1873. The numbers indicate relative measurements only:—

Iron bar ...	36 in. long,	0·5 in. diameter	= 21	divisions.
"	$9\frac{1}{4}$ "	1·0 "	= 6·5	"
Cobalt bar...	$9\frac{1}{4}$ "	1·0 "	= 5·5	"
Nickel bar ..	$9\frac{1}{2}$ "	1·0 "	= 0·0	"

With increased tension given to the spring, and using 20 instead of 10 Grove cells to excite the helix, a slight move-

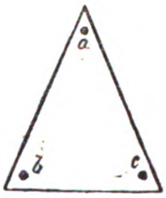

Fig. 3.

ment of 1·5 division in the direction of *shortening* was noticed with the nickel.

Many hundred experiments were made subsequently, confirming the general results here given, but absolute measurements with this apparatus were difficult, and, moreover, by its construction it did not allow the nickel to exhibit its full and proper action, accordingly the experiments were put aside till July, 1876, when, on repeating them with a new apparatus the fact of the opposite behaviour of nickel to that of cobalt and iron, under magnetisation, was fully confirmed, but no publication of the numerous experiments has been made, as I was still dissatisfied with the working of the apparatus.

After repeated trials of various devices the instrumental arrangements that I found succeed the best for the measurement of these minute quantities was a modification of M. Cornu's optical lever. Fig. 3 represents a

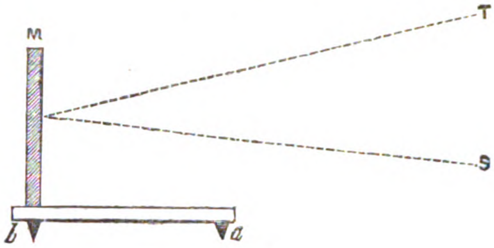

Fig. 4.

triangular piece of metal, having three points, *a b c*, in the angles of the triangle. M (Fig. 4) is a mirror, vertically placed over the two points *b c*. The point *a* rests upon the end of the metal bar, the elongation of which has to be measured, whilst the points *b c* are supported by a fixed arm. When the bar elongates the point *a* is pushed upwards, and thereby a slight tilt is given to the mirror M. The image of a distant scale, S, is reflected from the mirror and received in a telescope, with cross hairs, T. The length of the lever—that is, the distance between the points *a* and *b*

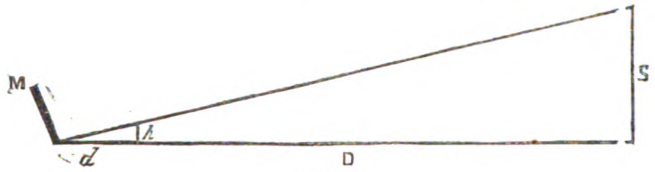

Fig. 5.

—can be accurately measured; in the instrument I generally employed it was an inch.

Let D (Fig. 5) be the distance of the scale from the mirror M, *d* the length of the lever, S the number of scale divisions which have traversed the cross wire of the telescope when the point of the optical lever is raised through the distance *h*, which has to be measured. As the arc *h* is extremely small, by similar triangles we have

$$\frac{d}{D} = \frac{h}{S},$$

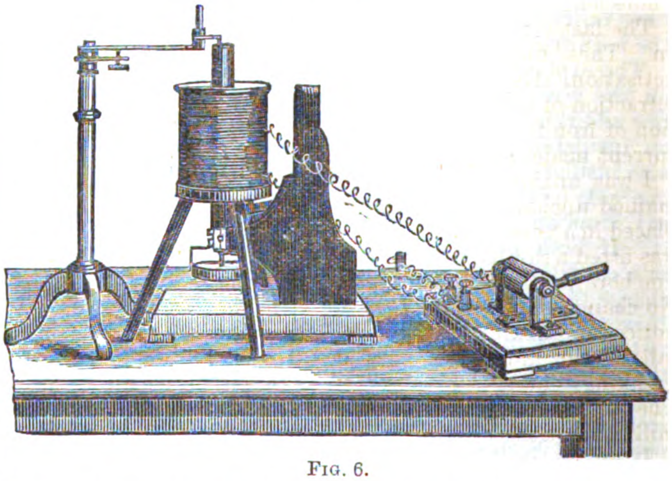

Fig. 6.

but as the reflection doubles the motion, half the value of S must be taken, whence we have

$$h = \frac{d \times S}{D \times 2}.$$

The general view of the arrangement is shown in Fig. 6. Various helices have been employed, the one with which the present experiments were made covered the whole length of

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the bars, and with 10 Grove cells magnetised the bars to saturation. The optical lever was supported on a more rigid arm than that shown, the most perfect steadiness of the whole arrangement being necessary; the bars usually were fastened to a stone pillar built up from the foundations, and isolated from the floor of the room.

Two optical levers were employed, the length of one being exactly half an inch, and of the other 10 millimetres. The scale was distant 260in. to 270in., and was in tenths of an inch.

The Iron and Cobalt bars were $9\frac{1}{4}$in. long, 1in. diameter, the Nickel bar was $9\frac{1}{2}$in. long and 1in. diameter. The following are some of the results obtained :—

SERIES A.

Scale, 260in. off. Optical lever, 0·5in. in length.

Iron.—Current made, motion of $\frac{1}{3}$rd of scale division = $\frac{1}{30}$th of inch ; current broken returned to zero.

Cobalt.—Current made, motion of $\frac{1}{4}$th of scale division = $\frac{1}{40}$th of an inch ; current broken returned to zero.

Nickel.—Current made, motion in *reverse direction* of 1 scale division = $\frac{1}{10}$th of an inch ; current broken returned to zero. With nickel the motion is so instantaneous that only by a close observation of the scale can any change be seen.

SERIES B.

Scale 270 inches off. Optical lever 1 centimetre in length.

Iron.—Current made, motion of 0·5 a scale division = $\frac{1}{20}$th of an inch ; current broken returned to zero.

Cobalt.—Current made, motion of 0·3 of a scale division = $\frac{1}{30}$th of an inch ; returned to zero on breaking contact.

Nickel.—Current made motion in *reverse direction* of 1·1 scale division = $\frac{11}{100}$th of an inch ; returned to zero on breaking contact. With iron and cobalt the motion was in the direction of *elongation*, with nickel in the direction of *retraction.*

Calculating out these results we have—

SERIES A.

Iron elongated $\frac{1}{31200}$th of an inch, or $\frac{1}{288600}$th of the whole length of the bar.

Cobalt elongated $\frac{1}{41600}$th of an inch, or $\frac{1}{384800}$th of the whole length.

Nickel contracted $\frac{1}{10400}$th of an inch, or $\frac{1}{96200}$th of its whole length.

SERIES B.

Iron elongated $\frac{1}{28000}$th of an inch, or $\frac{1}{259000}$th of its length.

Cobalt elongated $\frac{1}{46000}$th of an inch, or $\frac{1}{425500}$th of its whole length.

Nickel contracted $\frac{1}{12600}$th of an inch, or $\frac{1}{119700}$th of its whole length.

The last series, B, is, on the whole, more to be depended on. These numbers may be taken for the maximum magnetisation. Experiments are in progress to determine if the retraction of nickel obeys a similar law to that of the elongation of iron for currents of various strength. Reversing the current made no alteration in the values obtained.

I was anxious to ascertain if the *volume* of the nickel remained unchanged under magnetisation. Hence the bar was placed in a vessel of water closed by a metal cap, into which was fitted a capillary tube (a thermometer tube of extremely fine bore), and the whole encircled by the magnetising helix. No change in the level of the water in the capillary tube was noticed on making the current, but on breaking a very slight fall of the index was noticed. No change on making or breaking contact was observed with either cobalt or iron. The shrinking with the nickel was less than the one ten-millionth of the whole volume of the bar.

It was noticeable also (as I have mentioned elsewhere in 1874) that the "magnetic tick" was heard well with nickel and cobalt, the latter especially so, the sound on making and interrupting the current having a sharp metallic ring. This would suggest the desirability of trying cobalt and nickel instead of iron for telephonic receivers.

Experiments are in progress to determine the effect of longitudinal tension and of temperature on the change of dimensions of the nickel and cobalt. Preliminary results indicate, as might be expected, that neither cobalt nor iron show any appreciable alteration in the amount they elongate when raised about 50° C. in temperature; nickel, on the other hand, is diminished considerably, the retraction being about three-fourths of what occurs at the temperature of the air.

THE (ELECTRIC) CONDUCTIVE AND INDUCTIVE CIRCUITS GEOMETRICALLY ILLUSTRATED.

BY F. C. WEBB, M.I.C.E.

(CONTINUED FROM PAGE 299.)

Thus, if A B (Fig. 17) represent the resistance of the pair A, B D will be the resistance of the pair B, and D C the resistance

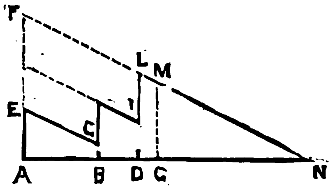

FIG. 17.

of the pair C. If A E be the electromotive force of the pair A, then A F (= 3 A E) will be the sum of the electromotive forces of the circuit; and if C N is the resistance of line wire attached to the copper pole, and the zinc at A is connected to earth, then, by the same process as before, E G H I L M N will be the line of potential of the circuit, C M being the potential at the copper pole attached to the line.

If the elements of a battery have not only different resistances, but also different electromotive forces, then, by the same projection, we may obtain the line of potential. Thus, if A B, B D, and D C (Fig. 18) be the resistances of three cells, A E, E F, and F G their respective electromotive forces, and C R is the external resistance, then A E K N O P R is the line of potential, and C M the potential at the copper pole. If the circuit is insulated and equidistant from all surrounding objects, then the potentials on half the circuit will be negative, and on the other half positive. The axis of the ordinates representing the potentials will, therefore, assume

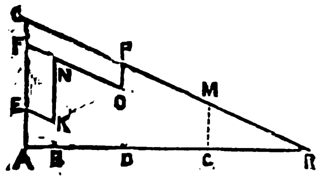

FIG. 18.

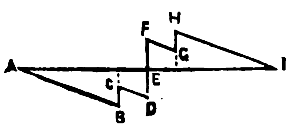

FIG. 19.

such a position that the total quantity of electricity constituting the static charge on one half the circuit shall exactly equal the total quantity of electricity of opposite name on the other half, for there cannot exist unequal quantities of electricity of opposite name. If the conductors throughout the whole circuit (including the liquid portions) are exactly of the same section and material throughout, and the same distance from surrounding objects, this condition would be fulfilled, if the axis of the ordinates assumed a position such that the areas of the figures A B C D E and E F G H I (Fig. 19) were equal; for in such case the densities of the electricity at every part would, since the surrounding objects are the same distance from each portion, be proportional to the potential at that part; and since, also, if the section and material is alike throughout, the surface is directly proportional to the reduced length of any part, it follows that the total quantity of negative elec-

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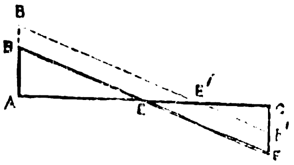
tricity is proportional to that part of the reduced length of the circuit which have negative potentials, multiplied by the potential at each fractional part, or, in fact, proportional to the area of the figure A B C D E; and in the same way the total quantity of positive electricity is proportional to the area of the figure E F G H I. The axis of the ordinates must in such case, therefore, assume such a position that the areas



IG. 20.

of these two figures shall be equal. In such case, therefore, with three elements, as in figure, the axis of the ordinates would pass through the centre of the centre electromotive force. If, however, the sections of the conductors forming the circuit are not uniform throughout, or being uniform, are of different specific conductivities, or being uniform and of equal specific conductivities, are situated at different distances from sur

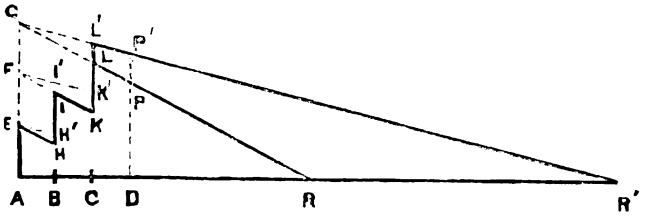


FIG. 21.

rounding conductors, then, since the density at any part is no longer of necessity proportional to the potential, nor the surface of the conductors proportional to the reduced length, the area of the figure A B C D, &c., no longer represents the charge, and consequently the position of the axis of the ordinates can no longer be found by this method.

For instance, suppose a portion of an insulated circuit A E C

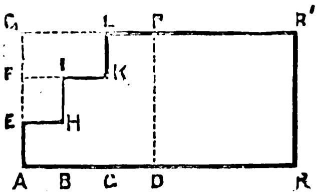


FIG. 22.

(Fig. 20) (which for simplicity I will suppose has only a single electromotive force = A B + C F) has a portion E C of much larger section than the rest of the circuit, but having, by virtue of its specific conductivity being less, the same resistance per unit of length, then, since the inductive resistance between equal portions of E C and surrounding objects is much less than between similar parts of A E and surrounding objects, the quantity on a fraction of E C is, with a given potential, much greater than on a similar length of A E. Thus we might have such a disproportion between the two parts that the triangle A B E no longer represents an equal quantity of electricity to that on E C F. The line of potential would, therefore, assume the position $B^1 E^1 F^1$, whereas, if the circuit had the same section and resistance throughout, the

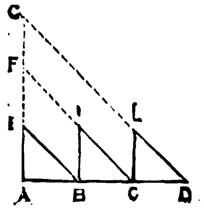


FIG. 23

line of tension would have passed through E. The increased surface of E C, in fact, acts somewhat like a Leyden jar attached to the circuit at some point between E and C.

We have already stated that the magnitude of the current in a circuit is represented geometrically by the steepness of the line of potential, the current being, in fact, directly as the tangent of the angle formed by the line of potential with the axis or datum line.

Thus in Fig. 21, if A E H I K L P R represent the line of potential in a circuit A R, then the steepness of the line PR shows the amount of current flowing, and if we increased the external resistance of the circuit by adding a resistance, R R', equal to the whole previous resistance of the circuit A R, then the line of potential becomes flatter, indicating less current flowing. The potential at the copper pole D rises from P to P'. All the other points, except E, also rise, and the figure becomes A E H' I K' L' P' R'.

If, now, having the same circuit as in Fig. 21, previous to adding the resistance R R', we insulate the end R, then the potential at D rises almost instantly to the full electromotive force of the battery, viz., A G (Fig. 22), as likewise does the potential at every point along the wire D R, and the line of potential becomes parallel to the axis, indicating thus no current.

If, now, instead of insulating R, we touch the circuit to earth at D, then the potential at D will evidently sink to zero, and by the same projection as before we obtain, as in Fig. 23, A E B I C L D. We see by this that in no place is the potential more than that of the electromotive force of one element, whilst the steepness of the line of potential has increased to its maximum, showing that on short circuit the maximum current is obtained.

ELECTRICAL ACCUMULATORS OR SECONDARY BATTERIES.*

BY PROFESSOR OLIVER LODGE.

No. VII.

In the last article I described a few typically instructive experiments that could be made with two clean lead plates immersed in dilute sulphuric acid, and connected at pleasure with a battery, or a galvanometer, or both. Before going on to the subject of coated plates, it may be well to draw attention to the consequences which a series of observations on plain plates will bring home to the experimenter.

If the surface of the plates are in the ordinary dull condition, he will find, on applying two Grove cells to them through a galvanometer, that the charging current at first is considerably stronger than it is after a few seconds. He will notice that oxygen rises from the + plate before any hydrogen rises from the − plate, and that as soon as both gases are freely given off the charging current is exceedingly small. In other words, the opposition electromotive force of the cell in this condition is very little below that due to two Groves; it is, I believe, about three volts. If the plates are brightened up just before insertion in the acid, the charging current will be weak from the beginning, and hydrogen will at once be given off. The stronger charging current observed for a few seconds in the first case was, therefore, due to the absorption of the first-formed hydrogen by a coat of oxide on the − plate; and if for this plate we use a purposely oxidised piece of lead, the absorption of hydrogen, and the consequent small opposition force and strong charging current, will continue for some time. The same thing would, no doubt, be observed in connection with the + plate if it ordinarily coated itself with an absorbent of oxygen; but as this is not the case, no particular effect is noticed when its surface is varied, unless, indeed, it be purposely coated with some oxidisable substance. To some extent minium and litharge act both as oxidisable and as reducible substances; and we have, therefore, the very important fact that it is much easier to send a current through two lead plates coated

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with litharge or minium than through two plates without any coating at all. The electromotive force of two Groves, which is almost overpowered by two clean plates, is amply sufficient to send a strong charging current through a cell with coated plates; at least, until the coatings are fully acted on, the gases no longer absorbed, and the cell full. As this state of things is approached the electromotive force of the cell gradually rises in a very decided manner.

With regard to the effect of amalgamating either or both of the lead plates with mercury, my experience leads me to conclude that amalgamation of the + plate is worse than useless. A coat of oxide of mercury is formed, which acts very fairly well as long as it adheres, or at any rate does not much obstruct the action of the peroxide of lead; but there is a certain point in the discharge when this coat falls off in a sheet, carrying with it apparently whatever peroxide of lead is present too, for the discharge current suddenly falls to zero whenever this happens. Of course the fall may be prevented mechanically, but the film still becomes electrically non-adherent, and therefore useless. Amalgamation of the — plate does, however, appear to help the occlusion of hydrogen, and is therefore so far advantageous.

The experiment of Professor Herschel, detailed in the last article, is capable of further elucidation. It consisted in observing the current produced by a piece of quite clean lead as the — plate, and a piece newly coated with peroxide as the + plate; the current is very weak, and hardly able to ring a bell. But it will be found on careful repetition that this feebleness of current is only arrived at after a second or two; the current at the first instant is quite strong. The real cause of the feeble current is a non-conducting film of sulphate or protoxide of lead, which forms on the clean lead plate the instant it is used to produce a current, and effectually screens it from the liquid. It causes, in fact, a sudden increase in the internal resistance of the cell. This can be proved in a variety of ways; such as observing that the lead plate so run down is incapable of giving a strong current when opposed to hydrogenised lead, zinc, or anything. Wiping removes the film, and restores the full power to the cell. Allowing the plate to remain in the acid for some time also removes the film to some extent, but slowly. As long as any hydrogen is present in the lead it appears to sustain oxidation alone, and the lead is unclouded; but as soon as the lead itself is attacked, the scum forms and the discharge current almost stops. By using amalgamated lead the scum is made plainly visible, and it can be seen to be wiped off when a cloth is used. The changes in the strength of the cell, according to the presence or absence of this scum, are very interesting and striking. The scum never forms when the plate is merely left in the acid, it is only when it is put into electrical contact with the + plate. In the case of lead exposing a large spongy surface, no doubt this film would take longer to form, especially as a larger amount of hydrogen would be then occluded. A short connection to the charging battery speedily removes the scum, not apparently by reducing it, but by making it peel off. Violent short-circuiting of the cell forms the scum much more quickly than when only a moderate discharge current is permitted. The picking-up of the cell during standing is closely connected with the formation and removal of this non-conducting film.

It may be asked whether this insoluble film cannot be avoided by immersing the plates in nitric or acetic acid instead of in sulphuric, so that no insoluble salt need be formed when the — plate is attacked. Certainly, if plates charged in sulphuric are removed to nitric acid to be discharged, the discharge current lasts strong a much longer time; but the + plate now suffers a seriously rapid deterioration, owing to the absence of a coating which is to it protective. It is, moreover, impossible to charge up the battery properly in any such substance which forms soluble salts of lead; and the whole beauty of the secondary battery is gone if its liquid has to be changed between charge and discharge.

The reasons why lead is pre-eminent among metals for accumulator purposes are, that both its oxide and sulphate are quite insoluble in dilute H_2SO_4, that its proxide is easily formed, and that it is conducting. The only other metal which satisfies these conditions is silver; but its sulphate is only partially insoluble, and, possibly for this reason, it does not answer. It would make a very light accumulator for some purposes, if it would work; but, for some reason or other, its power falls off with great rapidity, whether it is tried in H_2SO_4 or in HCl. The latter does rather the best, and it may be that its fall is only due to a rapidly-formed scum of chloride, which speedily reduces both plates to the same condition. A chloride, moreover, not being a conductor, could never take the place of a peroxide.

A curious experiment may be tried with copper, showing the necessity for a conducting, and at the same time an insoluble, substance as a coating to the plates. Take two slips of copper, say 5 centim. by $1\frac{1}{2}$ centim.; immerse them in dilute sulphuric acid or sulphate of copper, and send a charging current from three Groves through a dead-beat galvanometer, such as Ayrton and Perry's. It will be found that the current, which at first passes easily, is gradually and rapidly weakened, until at length the needle, which was at first deflected 20deg. or 30deg., has returned to within 1deg. of zero.

If the current be now stopped for a few seconds, and then renewed, the needle jumps up to 10deg., say, but rapidly and almost suddenly comes down to 1deg. again. If the current be interrupted for a longer time, it will take longer to come down again when renewed. But scarcely any discharge current can be got from the cell. The reason of the weakening of the current must be a coating of pulverulent material on one or both of the plates, which resists the passage of the current. A small amount of waiting dissolves a good deal of this off, and accordingly the charging current rapidly picks up again. Instead of a galvanometer an ordinary gas voltameter will serve for this experiment; the changes in the strength of the current are most striking. A certain *intensity* of current is, however, necessary, and nothing of the kind is observed when *large* copper plates are used.

If a cell, such as a Sutton cell, where the salt of the — plate is soluble (which, considered by itself, and without reference to the + plate, is, as we have seen, an advantage) if such a cell is violently short-circuited, and made to produce too strong a current, it is probable that oxide is formed on the — plate faster than it can be dissolved, and that accordingly a protective film is formed, which temporarily stops the action. If such a cell permanently falls off, it must be owing to the deterioration of the + plate by local action, which is very difficult indeed to avoid when soluble salts, such as sulphate of copper and sulphate of zinc, are present in the cell. In fact, the requirements of the — plate are, unfortunately, somewhat in antagonism to the requirements of the + plate, and what benefits the one is usually fatal to the other.

SUBTERRANEAN ELECTRICITY.

The *Practical Mechanic* for August, 1843, has the following note under the above heading:—" Mr. Were Fox has laid before the Cornwall Polytechnic Society his extended researches in subterranean electricity. The experiments were conducted in Pennance Mine, near Falmouth. Ore-points, about 14 to 18 fathoms asunder in a direct line, consisting of copper and iron pyrites in two nearly E. and W. veins, were connected by a pair of copper wires, leading through a shaft to the surface. The current has been constant for more than eight months. A galvanometer, not very sensitive, needle, $2\frac{1}{2}$ inches long, moved on a pivot, with 48 coils of wire, was permanently deflected 14deg. to 15deg. Another, having a suspended astatic needle and 140 coils, suffered a permanent deflection of about 40deg. The electro-magnetic and decomposing effects of these subterranean currents also afforded unequivocal evidence of their energy. And Mr. Fox obtained an electrotype copper plate $1\frac{1}{2}$ inch long, $1\frac{1}{4}$ wide, and 1-30th of an inch thick, by their agency. In a few days crystals of copper were observed forming on the negative pole, but it was nearly two months before the apparatus was removed from the circuit, when the deposited metal was detached from the plate, having received

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its impression '*vi insitâ terræ.*' Whilst the experiment was in progress at the surface, the water invaded the mine, but without interrupting the process; it appeared that the electric action was rather increased than diminished by this circumstance. Before the influx of water an ore-point in the north vein was connected with *rock* near the south vein (generally the wall of the vein), and an ore-point in the south vein was likewise connected with *rock* near the north vein; in both which cases currents, more or less feeble, were detected passing towards the latter through the wires, which were insulated by wooden poles stretched at intervals across the galleries. It is probable that the moisture on the rocks conducted the electricity from the ore to the metal, however imperfectly; and when different metals—as platinum and zinc—were successively substituted for the copper in contact with the rocks the currents were modified in their force according to the metal employed, but were seldom changed in their direction. The action was most decided when the place of contact with the rock was near ore; and sometimes the end of the wire, or rather the piece of copper attached to it, was rubbed by an assistant against the walls of one of the veins, or the sides of a '*cross cut*' between them. Under these circumstances the astatic needle was several times suddenly much deflected, and the parts of the rocks from which this increased action proceeded having been marked they were broken away, when iron pyrites were in every instance found embedded in them; and there can be no doubt that the smallest branch of copper or lead ore might have been detected in like manner. On several occasions the ends of the opposite wires were placed in contact with the rocks near the two veins, when there still appeared to be a tendency in the currents to pass in the same direction; but often they could not be detected, or were too feeble for their direction to be determined with certainty. Pieces of copper pyrites, attached to the wires and embedded in wood, were likewise used, instead of the metal, for producing contact with the rocks, and with still less effect; and when the contact was made with platinum and zinc in succession, the currents were in opposite directions, and in accordance with the action of those metals respectively, so that the existence of *independent currents* under the circumstances described, though more than probable, was not clearly proved. Electricity, generated by a pair of zinc and copper plates, was transmitted through the rocks between the two veins from north to south, and also from south to north, in order to detect any independent currents traversing the rocks, by a *differential* effect on the needle. This method appeared likely to be a very delicate test of electric action in rocks, but no decided results were obtained, the currents passing in opposite directions, apparently with equal facility; at least, the few experiments hitherto made in this way have not led to any satisfactory conclusions relative to the point in question. It should be remarked, however, that the astatic needle employed was inconveniently sensitive, and was often set in motion when the cause was not very obvious. It has been long known that electric currents will traverse a very considerable thickness of rock or strata; but in what degree this property may be modified by the nature or texture of the rocks, the saline contents of the subterranean water, or the proportion of ores included in the circuit, remains to be ascertained. If the influence of these different circumstances should greatly vary, electric currents, generated by given elements, might be rendered available on various occasions; to ascertain, for instance, the connection of saline springs not very distant from each other often appearing at the surfaces or in mines; or of a metalliferous vein discovered in one place, with a vein which has been worked for ore in another."

DIRECT UNITED STATES CABLE COMPANY.—This company give notice that the interest due on the 15th inst. on their Six per Cent. Debenture Loan will be paid on and after the 16th inst. at the Consolidated Bank, Threadneedle-street, E.C., where coupons should be left for examination three clear days before applying for payment.

REUTER'S COMPANY.—The directors of Reuter's Telegram Company (Limited) have declared an interim dividend at the rate of 5 per cent. per annum for the half year ending 30th June last.

ELECTRIC AND GAS ILLUMINATION.*

BY C. M. LUNGREN.

The period of contest and denial over the question of the possibility of producing a light of low intensity by means of electricity, that would be suitable for the general purposes of interior lighting, has about drawn to a close. It is now pretty generally conceded—what there has never been any reason for denying—that the known laws of electric transmission interpose no bar to the successful solution of the problem, but that the difficulties in the way are solely of a practical kind. And it is, further, quite generally agreed that these practical difficulties have been for the most part resolved, and the question reduced down to one of cost simply; and, while a good deal of discussion has taken place upon this point, but little has been written that will enable the general public to form a judgment upon the subject, and arrive at a trustworthy opinion of the relative cost of it and gas under actual commercial conditions.

In estimating the relative cost of the two illuminants, it has been common to compare simply the cost of the materials consumed in their production, or, when the cost of the apparatus necessary to generate the electricity has been taken into account, this has usually been upon the basis of a limited production, and, to this extent, unfair to electricity. A comparison, to be of any value, should be between plants of a size sufficient to reduce the cost to the lowest point at which it can be commercially maintained, and should include all of the items entering into it. The attempt has been made, in the following pages, to institute such a comparison, and present the facts in the case as they are, so far as they can be obtained. The comparison is upon the basis of works capable of producing a million feet a day, as, in such works, gas can be made as cheaply as in any that are larger. The figures for the electric plant are based upon the work of Mr. Edison, as he is the only one who has so far made any attempt to put in an electric plant upon an industrial scale; and for that reason, further, only his system of distribution is considered, though it may be a question whether it is the one which will prove most satisfactory in practice. An objection to it of considerable force, in the opinion of some, is the difficulty of handling engines and boilers with sufficient rapidity to meet great and sudden variations of demand, such as not unfrequently occur during the seasons of the year in which the weather is changeable. The variation that experience has shown takes place at different periods of the day can be met readily enough. On this account, and on account of the greater freedom secured in the matter of working various pieces of apparatus without interference, it would seem that the system of distribution which includes a storage-battery would be preferable, and may, perhaps, become the final form adopted in electric installations. It cannot well enter into the present calculation, however, as there are no data with reference to the first cost and depreciation available, and because the present secondary batteries do not seem to have yet reached a satisfactory commercial form.

The cost of such a plant for coal gas will vary in this country from 2,500dols. to 4,000dols. for each million feet of the yearly make, but 3,000dols. may be taken as a fair average. Owing to the great variability in the demand for light at different seasons of the year, a gas works of this size will be called upon to furnish but 200,000,000 instead of 365,000,000 feet a year. The plant will therefore cost 600,000dols. Of this, 250,000dols. may be taken as the cost of the mains, which, in average conditions, will have, for a works of this size, a total length of fifty miles, covering a district of about three square miles. To compare an electric with a gas plant, it is necessary to know the number of five-foot burners that will be maintained at the time of greatest consumption, as on this depend both the amount of horse-power required and the size of the mains to transmit the current.

The variation in the demand for light from hour to hour, as it would occur in average conditions on a bright December day, is exhibited in the following table, in percentages of the total make for the twenty-four hours:

7– 8 A.M.	$1\frac{1}{2}$ per cent.	7– 8 P.M.	12 per cent.
8– 9 ,, ...	$\frac{1}{2}$,,	8– 9 ,, ...	12 ,,
9–10 ,, ...	$\frac{1}{2}$,,	9–10 ,, ...	10 ,,
10–11 ,, ...	$\frac{1}{2}$,,	10–11 ,, ...	6 ,,
11–12 ,, ...	$\frac{1}{2}$,,	11–12 ,, ...	5 ,,
12– 1 P.M.	$\frac{1}{2}$,,	12– 1 A.M.	$1\frac{7}{10}$,,
1– 2 ,, ...	$\frac{1}{2}$,,	1– 2 ,, ...	$1\frac{7}{10}$,,
2– 3 ,, ...	$\frac{1}{2}$,,	2– 3 ,, ...	$1\frac{7}{10}$,,
3– 4 ,, ...	$\frac{1}{2}$,,	3– 4 ,, ...	$1\frac{7}{10}$,,
4– 5 ,, ...	$7\frac{1}{2}$,,	4– 5 ,, ...	$1\frac{7}{10}$,,
5– 6 ,, ...	16 to 20 ,,	5– 6 ,, ...	$1\frac{6}{10}$,,
6– 7 ,, ...	14 ,,	6– 7 ,, ...	$1\frac{7}{10}$,,

This shows the time of greatest consumption to be between the

* From the *Popular Science Monthly*.

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hours of five and six, and the demand as high as twenty per cent. of the entire daily make. In the case of the plant under consideration, the maximum number of burners that will have to be maintained at any one time is therefore 40,000.

Before proceeding to estimate the cost of the plant to generate and distribute electricity sufficient to maintain this number of burners, a few words descriptive of Mr. Edison's system will be desirable, especially as there appears to be considerable misapprehension on the subject. The distribution is what is known as in multiple arc—that is, the lamps are placed upon cross-wires between the conductors. Imagine a ladder erected upon an ordinary railway, so that it stands across the track, each foot resting upon one of the rails. Then these rails will represent the outgoing and returning street-conductors; the side-bars of the ladder, the house-conductors; and each rung, a lamp. The dynamo-machines generating the current are arranged in exactly the same way with regard to the circuit, all the positive poles being joined to one main conductor, and all the negative ones to the other. The arrangement is what is known, in the case of electric batteries, as coupling for quantity, as opposed to coupling for intensity, and is similar to that of a number of pumps discharging water into a common main. This disposition of the electric-producing apparatus has the important advantage that the reserve plant, to meet contingencies, needs to be but a fraction of the total one; while, if each machine supplied an independent circuit, the plant would have to be in duplicate. As is well known, the steam engines driving the dynamos are coupled directly to the machines, without the intervention of belts or gearing, the combination being termed the steam-dynamo.

The street-mains consist of wrought-iron tubes about two inches in diameter, containing two half-round copper rods imbedded in an insulated resinous cement. A main of this kind is carried continuously around each city block. At the intersections of the streets the conductors are brought together and joined to a main somewhat larger, termed a feeder, which supplies the current to these four blocks. It will thus be seen that the system of mains and the mode of production of the electricity are as readily capable of expansion to meet increased business as in the case of gas. The mains can be tapped anywhere for new consumers, and to meet this increased demand it is only necessary to run a feeder to the place of enlarged consumption, and increase the producing plant sufficiently.

What, then, will be the cost of such an electric plant to do the same amount of lighting as the above gas plant? If we take eight 16-candle lamps, maintained throughout the whole system for each actual horse-power applied to the dynamo-machine, engines with a normal capacity of 5,000 horse-power will be required to sustain the maximum number of burners. This will include the reserve plant, as engines of a normal capacity of forty-two hundred can readily be forced to five thousand horse, or twenty per cent., to meet this extreme demand, and, with the generators arranged after Mr. Edison's plan, this per cent. is an ample reserve. The maximum demand can, of course, be met either by forcing, or by running the entire plant at its normal rate, and forcing only in case of accident. To cover a district of three square miles, two distributing stations will be sufficient. The steam dynamos may be taken as of two hundred horse each, working normally. The present steam dynamos are of but one hundred and twenty-five horse, but they can be made two hundred horse with but slight increase of cost, which Mr. Edison contemplates doing in future installations. This will give thirteen steam dynamos to one station and twelve to the other. These may each be placed at 8,000dols., making a total for the two stations of 200,000dols. That this is a sufficient allowance will be evident upon considering the machines in detail. There are first the two hundred horse-power engines. No one will question that these can be obtained by a large buyer at 18dols. per horse-power, or 3,600 dols. each.* This leaves 4,400dols. to cover the cost of the dynamo. The material in these, as now being constructed, is as follows:

Iron (wrought and cast)	40,700lbs.	at	3½ cents.	=	$1,425 00
Zinc (cast)	680	,,	6 ,,	=	40 80
Copper	3,440	,,	28 ,,	=	963 20
	44,820				$2,429 00

This leaves 2,071dols. for the cost of construction, which will be recognised as more than enough, when it is remembered that the cost of the iron as above given includes its shaping, and that the copper on the armature is in the form of bars and discs, which, with suitable tools, can be expeditiously constructed.

Adding 25 per cent. to the cost of material for the 200-horse machine, there is still left 1,364dols. to be expended in construction. It seems to me, therefore, that 8,000dols. is a safe estimate of the cost of such steam-dynamos. Regarding the boilers, the sectional or water-tube boiler, on account of its freedom from dangerous explosions, the smaller space occupied by it, its higher efficiency, and less cost for repairs, is in every way the best suited for a purpose of this kind. Such a boiler set ready for use, including stack and apparatus for handling coal and firing, will cost 20dols. per horse-power. The total boilers would, therefore, cost 100,000dols., making the entire producing portion of the plant, exclusive of real estate, 300,000dols.

As the Edison mains are now being laid, they will transmit a current sufficient to maintain from sixteen thousand to eighteen thousand sixteen-candle lamps. Taking the former figure, this is one and a quarter mile per 1,000 lamps. Basing the calculation for mains upon this mileage and the size of the present mains, the same number of miles of electric mains would be required as for gas. The present conductors are, as stated, in the form of half-round copper rods, of varying sizes, diminishing, of course, as they proceed from the station. They are, however, equivalent to round rods with a uniform diameter of one half inch. Such rods weigh $\frac{755}{1000}$ of a pound per foot, and 3986·4 pounds per mile, costing, at 28 cents per pound, 1,116dols. per mile. As there are two rods in each main, the cost per mile for copper would be 2,232dols. To this must be added 1,200dols. per mile for wrought-iron tube, boxes at the joints between the mains and house-wires, and insulating material, and 1,000dols. per mile for laying, making the total cost of the main per mile, laid ready for use, 4,432dols. Four-fifths of the mains would be of this size, the other fifth being feeders equivalent to round rods three-fourths of an inch in diameter. These latter weigh 1·69 pound per foot, and would, therefore, cost 2,340dols. per mile, and, taking the cost of enclosing tube, insulation, and laying the same as above, their total cost per mile would be 7,196dols. The total cost of the mains, 40 miles at 4,432dols. per mile, and 10 miles at 7,196dols. per mile, would, therefore, amount to the same as the gas mains, viz., 250,000dols. If real estate be added at 50,000dols., which in most cities requiring this size of plant would be ample, the total cost of the electric plant would be the same as one for gas.*

The elements entering into the cost of the light to the company furnishing it are, in each case, the interest on the investment, depreciation, or the amount spent each year in keeping the property in good condition, the labour of all kinds—in the manufacture, distribution, and management—and, lastly, the cost of the materials used in its production. In the case of gas but a few of these items as they occur in American works are obtainable, so that recourse must be had to the published reports of foreign companies, and the like items estimated for this country. Of these, the reports of the London companies as analysed by Mr. Field will best serve for the purpose of the present comparison.† Taking first the item of depreciation, we find that for the four metropolitan companies this was, for the year 1880, on the producing portion of the plant 9·86 cents per 1,000 feet of gas sold, or about five and a half per cent. on the cost of this part of the plant as it has been taken in this paper. Calling this ten cents a thousand feet, we have 20,000dols. a year as the expenditure under this head, which is probably well within the actual figures of most American works. In the case of the electric plant 4 per cent is a sufficient allowance for the same item, which gives a yearly charge of 12,000dols., and a cost of six cents per 1,000 feet.

Depreciation of this part of the plant varies but little with different works, as the conditions upon which it depends are relatively constant, but that of the mains is, on the other hand, exceedingly variable. In a dry, open soil, gas-mains will last a great length of time, and even when they become entirely rusted through they will still continue efficient if undisturbed. They do not, however, remain undisturbed, so that in the most favourable conditions some expenditure is necessary to keep them in working condition. We shall probably not be far wrong if we take this at 2 per cent. of the entire cost of the mains, which includes, of course, that of laying them. This item, then, becomes in the case of our gas plant 5,000dols. per year, and 2½ cents per 1,000 feet. In the case of the electric mains, this percentage must be reckoned only upon their cost, exclusive of the copper, as this latter is practically indestructible, and can be used again and again. The amount upon which to reckon the two per cent. depreciation is, therefore, 2,200dols. × 50 = 110,000dols., and the

* Mr. Edison informs me that engines of 200 indicated horse-power are being purchased by him for 1,750dols. each, delivered in New York. This estimate is, therefore, much too high, but, as the comparison of plant in the text is based upon it, I have thought it best to let it stand, and point out the needed correction here.

* While this estimate seems to me not far from the expenditure that would be actually required for this size of plant, it should be stated that it is lower than any of those given by the electrical experts examined by the Select Committee of the House of Commons in its consideration of the Electric Lighting Bill.

† Having been unable to obtain a copy of Mr. Field's "Annual," I have taken the figures as quoted from this for the year 1880 by Mr. Dowson, in a recent lecture before the Society of Arts.

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yearly charge 2,200dols., which gives 1·1 cent per 1,000ft. The interest on the investment is the same in each case, and amounts to 24,000dols. a year, at four per cent., and to 12 cents per 1,000ft. These items include all that are properly chargeable to the expense account of the plant save taxes, which would be about the same in each case, and which may be neglected for the present. The plant account, then, stands, in the two cases, for each 1,000ft. or its equivalent:—

	Gas.	Electricity.
Interest	12·	12·
Depreciation of producing works	10·	6·
Depreciation of mains	2·5	1·1
Total	24·5	19·1
	19·1	
Balance in favour of electricity	5·4	

The items entering into the cost of coal gas are, exclusive of management, rent and taxes, &c., the cost of coal, of manufacturing, and of distribution. Taking the last first, we find 4·4 cents per 1,000 feet as the cost of this item for the four metropolitan companies. Putting this at 5 cents for American works, and deducting from this 2½ cents for the depreciation of mains, which is included in this charge, there is left 2½ cents for the cost of the labour of inspection of meters, &c., which constitutes the charge of distribution, and which would be about the same in both systems.

As the depreciation of the mains is not given separately, this item is liable to error, due to a wrong estimate of such depreciation, but, as it affects both systems similarly, it will not vitiate the results. Under manufacturing, the English report includes purifying, salaries, the wages for carbonising, and wear and tear, which latter item has already been carried to the plant account. The first of these amounts to 1.82 cent., the second ·82 of a cent, and the third to 7·16 cents, making a total of 9·8 cents per 1,000 feet. This is probably much below the actual amount paid for these items in American works, but I am assured on excellent authority that in works constructed after the best modern models purification should cost the gas company nothing, and that all labour in the manufacturing department should be covered by an outlay equivalent to one man's wages (2·50dols. per day) for each 40,000 feet of gas made per day. As the same amount of labour would have to be paid for each day in the year as on the days of greatest demand, this would amount, for a daily make of 1,000,000 feet, to 25 men whose wages at 65dols. per month (26 × 2½) would be 19,500 dols.* a year, or 9¾ cents per 1,000 feet of the actual make. Including the cost of purification, and calling the amount 12 cents, we shall not be far wrong, or, at least, shall not exceed the actual outlay in the average works of this size. In the case of electricity the labour required at each station would be:—

One chief engineer	125 dols. per month.	
Three assistants (at 75dols.)	225 ,,	,,
Five firemen (at 60dols.)	300 ,,	,,
Total	650 ,,	,,

—making 15,600dols. a year for the whole manufacturing plant, and 7·8 cents per 1,000ft. To this may be added 1⅕ cent. to cover salary of electrician and incidental labour, bringing the item up to 9 cents.

(TO BE CONTINUED.)

ANGLO-AUSTRIAN BRUSH ELECTRICAL COMPANY (LIMITED).

The first general meeting of shareholders in this Company was held on the 10th inst., at the offices, 4, Copthall-buildings, E.C., under the presidency of Sir William Stephenson, K.C.B.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said: The present meeting is convened in accordance with our statutes, which require that the first general meeting of the Company should be held within four months after registration. I need hardly remark that it would be inexpedient at the present stage to enter into details regarding a good deal that the board is doing for establishing the Company's business, but there are several matter on which the shareholders would probably like to be informed, which I will take this opportunity of communicating to them, and I also wish to say a few words regarding the general policy the board is pursuing. In the first place, as regards the Company's capital, I may inform you that 26,668 ordinary shares were subscribed by the public in response to the prospectus we issued. I have also to inform you that a modification was agreed to by the vendor in the arrangement with him by which he accepted for the patents transferred by him only £27,000 instead of £55,000 in cash on account of the total sum of £75,000 due to him. The balance of the purchase money he accepted in 5,600 shares fully paid up, and 8,000 shares credited with £2 10s. per share paid up. By this modification the company has a larger proportion of its subscribed capital available for developing the business than if the original mode of paying for the patents had been adhered to. With regard to the business of the Company you are aware that we possess the Brush and Lane-Fox patents for Austria and Hungary, together with certain advantages in connection with same in Roumania, where no patent laws at present exist. So far as concerns our Articles of Association, however, we are at liberty to carry on business in any other country. I think I need not dwell upon the merits and commercial value of the Brush system of electric lighting, which have been amply proved by the substantial results obtained in the United States and in England, but I may state that we have satisfied ourselves that a large field exists in Austria, Hungary, and Roumania for which this class of lighting is suitable, and I may add that Brush lights are already in use at the present time in several manufactories in Austria. But whilst we believe that the development of the Brush system in its proper field will prove a highly remunerative business in the countries referred to, we are satisfied that the development of a system of distribution of electrical energy for domestic lighting and other purposes will prove a business of vastly greater importance. It is not so long ago that it was considered a great feat to operate fifteen or twenty lights from one dynamo machine, and it is only a very short time ago that an enormous stride was considered to have been made when some of the streets in the city were lighted up by means of Brush lamps operated by a machine in Lambeth, and the Opera House in Paris was lighted up by means of Brush lamps, operated by a machine placed in the exhibition building in the Champs Elysées. But, to-day, the talk is not of 30, nor 40, nor 50 lights, but of thousands of lights operated from central stations, and it is not light only that we look to obtain from these central stations, but we expect them to supply us with heat and power; we expect to get our dinners cooked, our hair brushed, and our boots cleaned by these central stations. In fact, it is now realised that it is possible to lay on electrical energy to houses in a town, like water or gas, with the main conductors always charged for consumers to draw on at any hour of the day or night. This is the problem we now have to face. Now, the possession of the Lane-Fox patents gives this Company advantages in connection with this part of the business which I believe it would be difficult to overestimate. I wish to dwell especially on this matter, both on account of its importance to the Company and because this part of Mr. Lane-Fox's invention is hardly known or appreciated, being applicable to a degree of advancement in electrical engineering which we are only now reaching. Although I do not profess to be a technical man, the matter has been made so clear to me that I think I can undertake to explain it. Mr. Lane-Fox appears to have conceived from the outset the idea of a general system of distribution of electrical energy. Dynamos, accumulators, and lamps were then in their infancy, but he foresaw the degree of perfection to which they would probably be brought; and whilst others were applying themselves to the improvement of matters of comparative detail, he, taking a bird's-eye view of the whole subject, applied himself to the study of how he could link together the various elements he saw growing into shape so as to constitute the comprehensive system of distribution of electrical energy which he had conceived would be necessary to make electricity a commercial possibility. The result of his labour was the particular part of his patent to which I now refer and which sets out a combination of dynamos, accumulators, and incandescent lamps or other apparatus, by means of which the main conductors in the system of distribution of a district can be kept charged with electrical energy at a constant pressure which can be drawn upon at all times for use in suitable apparatus to produce light, heat, power, or other effects. Now, it is very important to understand what this patented combination really covers. We probably, most of us, have a general notion of the offices which would be performed by the dynamos, accumulators, conductors, and lamps in a general system of electrical distribution in a town. We have a general idea that the current is generated by the dynamos when put in motion by steam engines or other motors, that the accumulators perform the duty of reservoirs into which the dynamos pump the electric force, and from which the lamps can draw the supply they require and when required. But it is, perhaps, not so generally understood, at any rate by the public, that the various patents one hears of for dynamos, accumulators, and lamps only cover details of construction, and that the fundamental ideas on which they are based are practically public property. I mean to say that the production of an electric current by mechanical action is not a patent, that the process of storing electricity by utilising the chemical effect of the electric current on certain substances is not a patent, and that the production of light by heating to incandescence in vacuo a filament of carbon or other substance is not a patent. All this can be effected more or less efficiently and economically by means of apparatus which is not patented, as well as by a great variety of patented apparatus; but dynamos, accumulators, and incandescent lamps, whether patented or unpatented, cannot be used in combination as a system except under Mr. Lane-Fox's patent. The question then arises, can a system of distribution be established without using dynamo accumulators and lamps combined in the manner patented by Mr. Lane-Fox? On this point I am advised that although it is possible to feed the lamps direct from the machines, as has been commonly done hitherto, without the intervention of accumulators it would be found, in a general system of distribution, that the difficulty of regulating the current to meet a varying demand, the additional cost which would have to be incurred to put down plant and machinery capable of meeting the maximum demand at any time, added to many other disadvantages, would practically put such an arrangement out of the field. It would be like attempting to supply water to a town without the intervention of reservoirs, or gas without the intervention of gasometers. It amounts to this, therefore, that Mr. Lane-Fox's patent practically covers the distribution of electrical energy on a large scale. I understand that in London alone, with its 4,000,000 inhabitants, at least thirty millions of pounds sterling are invested in the gas industry, and this will enable us to form some conception of the business which may be developed when electricity comes to be laid on like gas, from house to house, and I think therefore it will be admitted that I was correct in the remark I made just now that I believe it is difficult to overestimate the value of a patent like Mr. Lane-Fox's, which places us in such a pre-

* The engineer furnishing the information on which this statement is based informs me that this should be $12,500, or $2.50 per 40,000 feet of the actual yearly, instead of the maximum daily, make. This would reduce the item 9¾ cents to 6¼ cents per 1,000 feet.

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eminently favourable position to introduce a general system of distribution of electrical energy. This question of the development which the applications of electricity is likely to take consequent upon the establishment of systems of distribution brings me to another point, viz., the position this Company should assume in relation to the business to be created. Austria, Hungary, and Roumania contain together a population of over 42 millions of souls. A large proportion of this population no doubt are not in a position for local reasons to avail themselves of our electrical energy, and possibly a further proportion may have the bad taste to prefer electrical energy supplied by others than ourselves. But assuming that one-tenth part only of the population come to us for electricity, it is obvious that it would be far beyond the powers of our Company, or indeed of any single company, to undertake the working and administration of the systems of electrical distribution which even the above mentioned small fraction of the country would require. Moreover, there are many reasons why the working of the systems of electrical distribution should be in local hands. In the opinion of the board the position this Company should take is that of pioneer in the first instance, and afterwards contractors and manufacturers, for the establishment of the systems of distribution which we believe and expect will result from our pioneering. The programme of operations determined on by the board in pursuance of this policy is to set up manufacturing works in Vienna forthwith, and at the same time to lay down a system of electrical distribution on a sufficiently large scale to demonstrate the practical and commercial possibility of the scheme. When the first test system is in satisfactory operation and it is known that our works are in running order, that we possess a properly organised staff, and that generally we can be depended on both in point of skill and responsibility to contract for the establishment of systems of distribution, and also for their maintenance and the repair of apparatus, we believe that the formation of local companies to own and work under our licenses systems of distribution for different towns and districts will not be a matter of difficulty. Of the practical success of the installations the board feels confident, and of the commercial success they feel equally sanguine in countries where the price of gas varies from 5s. 4d. to 12s. 8d. per 1,000 cubic feet. Now you will probably wish to know something of what we have done so far towards the realisation of our schemes. On this point—although, as I mentioned before, I am obliged in the interests of the Company to speak with some degree of reticence—I think I can say enough to satisfy you that the board has not allowed the grass to grow under its feet during the short space of time that has elapsed since the Company was launched. In the first place, we have secured in Vienna temporary premises in which we are commencing our manufacturing operations, pending the completion of negotiations for the purchase of one or other of two buildings either of which is in every respect suitable for our permanent requirements. We have ordered, in England, a large number of machine tools for our factory, and many of them are already on their way to Vienna. The nucleus of our staff in Vienna is formed and is now engaged in organising our works. A committee of the board, consisting of myself and two directors, has just returned from a tour in Austria, Hungary, and Roumania, where we have been engaged in making general arrangements for carrying on the Company's business. An important contract is being negotiated for the lighting of one of the principal buildings in Vienna, to form part of our first system of distribution. Negotiations are also proceeding for the sale of licenses for certain districts, and an agreement has been signed for the conditional sale of the license for one important district. The board is, however, very strongly of opinion, that the sale of licenses should not be pushed until the Company is in possession of a working organisation and manufactory capable of meeting the requirements of licensees. On the success of the subsidiary companies depends in the opinion of the board the real success of our Company, and we think it would be short-sighted policy for the sake of immediate returns to part with licenses at present which must become of much greater value so soon as the satisfactory working of our first installation has established our name. The committee, therefore, rather directed its efforts in Austria to securing the co-operation of persons of influence under an arrangement by which a participation is to be secured to them in the benefits which we shall derive from the formation of local working companies, in consideration of their contributing to the expenses of the experimental installations, and affording us their support in our operations. I am happy to say that satisfactory progress is being made in the matter. In Roumania, the committee had the honour of several interviews with the King, who showed the greatest interest in the question of electric lighting. His Majesty has given us orders to light up experimentally his Winter Palace, and the grounds of his Summer Palace at Bucharest. He has also given us the order to put down the leads for a system of distribution in his palace of Sinaia in the Carpathians, and the estimates for the permanent lighting of this palace by electricity are under consideration. The staff for carrying out the above work is on the spot, and some of the apparatus for Bucharest has already arrived, and is in course of erection. The whole of the remainder is on its way out. The initiative taken in this matter by their enlightened, liberal, and enterprising sovereign bids fair to secure to the Roumanian people the prestige of being the first nation in the world to adopt and reap the benefits of a comprehensive system of distribution of electrical energy. Before concluding, there is one more matter to which I wish to refer, although it is one on which it will, probably, be necessary to call you together again. We have now in hand, as you are aware, business in Austria, Hungary, and Roumania. The two former countries, although under the rule of a common sovereign, are essentially distinct and separate. All these countries are desirous that their enterprises should bear the stamp of their own nationality, and although they are all disposed to view with favour the introduction of a business from England, it is not a recommendation in the eyes of the two latter that the name of Austria should appear in the title of our Company to the exclusion of their own. Furthermore the board is of opinion that the name "Brush" in the title of the Company, besides being extremely difficult to translate into a foreign language in the sense in which it stands, is rather misleading, having regard to the development which the Lane-Fox patents are likely to take in the hands of this Company. Under these circumstances the board are of opinion that it would be advantageous to the Company to alter its title so as to bear a less distinctive character in respect of nationality and system. We think that some such title as the "International Electrical Company (Limited)" would be more suitable, the more so as we have business in view in another country, concerning which I hope to be able to give you some account when we meet again to settle the question of the alteration of our name. I trust that what I have said will satisfy you that the board is giving its earnest attention to your business. I shall be happy to afford further information should anything I have said not be quite clear, but at the same time I beg you to remember, should you ask me any questions, that information on matters of detail is of far greater use to our competitors than to you.

No shareholder rising to ask any question,

Mr. Trevor proposed a vote of thanks to the chairman and the directors for the energy they had shown in the transactions of the business of the Company.

Mr. Noel seconded the motion, which was carried unanimously.

The Chairman, in reply, stated that if the shareholders were, as he hoped, satisfied so far with the conduct of the directors, they would do nothing to forfeit their good opinion.

The proceedings then terminated.

Brazilian Submarine Telegraph Company.—It is notified that the accounts of the Brazilian Submarine Telegraph Company (Limited), subject to audit, show a profit sufficient to enable the directors to recommend a final dividend of 3s., and a bonus of 2s. per share, making, with previous payments, 7 per cent. for the past year. Of the balance (£51,295) the sum of £50,000 has been placed to the reserve fund, increasing it to £407,663, and £1,295 carried forward.

Submarine Cables Trust.—This company announce that the coupons due on the 15th inst. will be paid on and after that date by Messrs. Glyn, Mills, Currie, and Co.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices Oct. 11.		Business Done Week Ending Oct. 11. Highest.	Lowest.
Anglo-American	50,	51	51	50½
Do. Preferred	82½,	83½	83½	82½
Do. Deferred	19½,	20½	20½	19¾
Brazil Submarine	11¾,	12¼	12¼	11¾
Cuba	9¾,	10¼	9¾	9¾
Do. Preference	16,	17	—	—
Direct Spanish	6¼,	6¾	6¾	6½
Do. Preference	15½,	16½	—	—
Direct United States Cable	12,	12½	12½	12 15-16
Eastern Telegraph	10¾,	11	11	10¾
Do. 6 per Cent. Preference	12¾,	13¼	—	—
Do. 5 per Cent. Debentures, 1899	101,	104	—	—
Eastern Extension	11½,	11¾	11½	11 9-16
German Union	9¾,	10¼	—	—
Globe Telegraph and Trust Company	6½,	6¾	6 11-16	6 9-16
Do. Preference	12½,	12¾	12½	12½
Great Northern	12¼,	12¾	—	—
Indo-European	30½,	31½	31½	31½
Mediterranean Extension	1¾,	2¼	2¼	2
Do. Preference	8,	9	8¾	8¾
Reuter's	12¾,	13¼	—	—
Submarine	250,	260	250	260
West India and Panama	1¼,	1½	1½	1 7-16
Do. 1st Preference	7½,	8	8¾	7½
Western Brazilian	6¾,	7¼	6¾	6¾
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1,	1¼	1 3-16	1 1-16
Oriental	¾,	1	¾	¾
United Telephone	10½,	11	10½	10¼

ELECTRIC LIGHT.

Anglo-American Brush	13¾,	14¼	17	13½
Maxim-Weston	¼,	½	¾	½
Eastern Electric	3,	3½	3	2

TRAFFIC RECEIPTS FOR SEPTEMBER, 1882.

Companies.	Sept., 1882.	Sept., 1881.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,250	2,030	220	—
Direct Spanish Telegraph Company	1,812	1,790	22	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	32,953	30,866	2,089	—
Eastern Telegraph Company	57,271	47,407	9,864	—
Great Northern Telegraph Company	21,280	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

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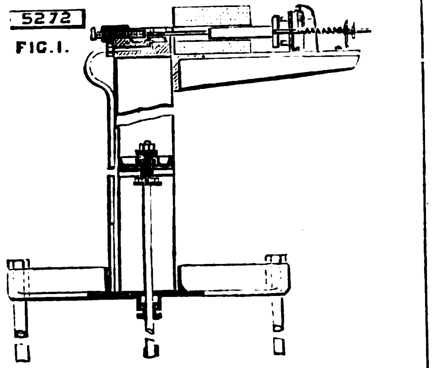
RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

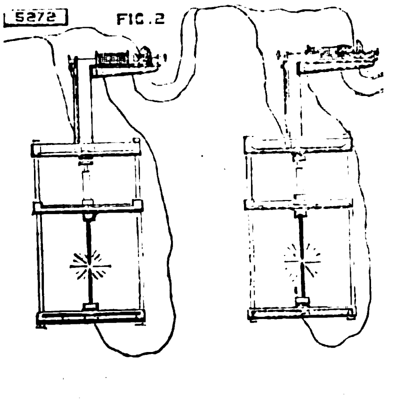
5272. Improvements in and Connected with Electric Lamps, *W. F. King and A. B. Brown, Edinburgh.—2nd December*, 1881. 6*d*.

This relates to an arc lamp. The upper carbon is held by the rod of a piston working in a vertical cylinder containing oil. The weight of the piston,



5272 FIG. 1.

&c., forces the liquid from the bottom through the pipe shown on the left-hand side of Fig. 1, and the rate of flow through this passage is automatically adjusted to correspond to the rate of consumption of the carbons. For the purposes of adjustment the pipe has for outlet at its upper end a small port in a horizontal port face, on which rests the

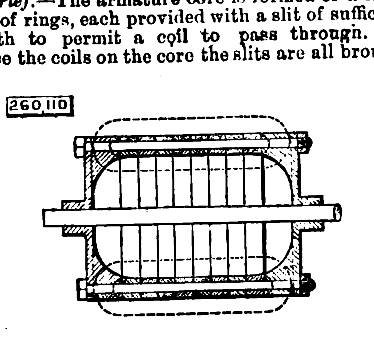


5272 FIG. 2

small slide valve shown; this latter is connected to the iron cone of the solenoid, the coil of which is in the circuit of the lamp. The action of the current combined with that of the spring effects the adjustment of the carbons. Fig. 2 shows the method of shunting the current past a broken-down lamp.

260,110. Armature for Dynamo-electric Machines, *James J. and Thomas J. McTighe, Pittsburg, Pa.—Field March* 28, 1882.

Brief.—The armature core is formed of a number of rings, each provided with a slit of sufficient width to permit a coil to pass through. To place the coils on the core the slits are all brought

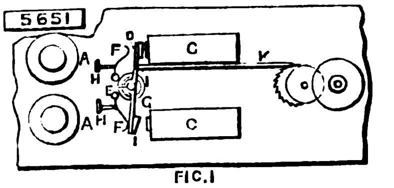


260,110

into line, and after the coils have been placed thereon the rings are turned so as to bring the slits to different circumferential points. The coils are thus locked into place, and by a proper adjustment of the rings the armature may be balanced. The whole is securely held by end plates and bolts,

5651. Improvements in Electric Current Meters, *St. George Lane-Fox, Westminster. —24th December*, 1881. 6*d*.

This relates to improvements on the inventor's patent No. 4626, dated 14th November, 1878, in which the position or motion of an armature due to the amount of current passing through a corresponding electro-magnet controls the working of the clockwork of a counting apparatus. Fig. 1 is a plan, and Fig. 2 a side elevation of the apparatus. The inventor employs a magneto-electric motor to give a constant motion to a certain shaft in the meter. C C are the magnets of the motor, G a shaft oscillating about axis E; D D are armatures. The magnets are put



5651 FIG. 1

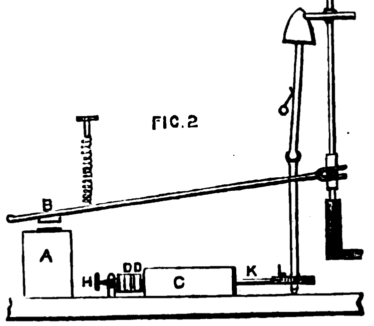
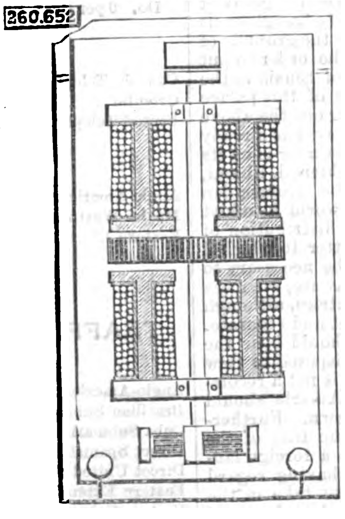


FIG. 2

into action alternately by springs F F which make contact according to the position of shaft G. Screws H H limit the time during which the current passes across the contact pieces. A pawl, K, oscillates with shaft G I, and engages in wheel L so as to move it through a definite angle for every oscillation of G. The motion of L is transferred to another shaft connected with the meter so as to make the annular velocity of this shaft vary with the position of the armature B^1, the position of which is due to the amount of current passing through the electro-magnet A, whose coil forms part of the circuit or a shunted portion of the circuit of the conductor through which the current is passing that requires to be measured.

260,652. Dynamo-electric Machine, *C. F. Brush, Cleveland, Ohio.—Filed June* 1, 1880.

Brief.—Surrounds the cores of the field magnets with a continuous band of sheet copper or

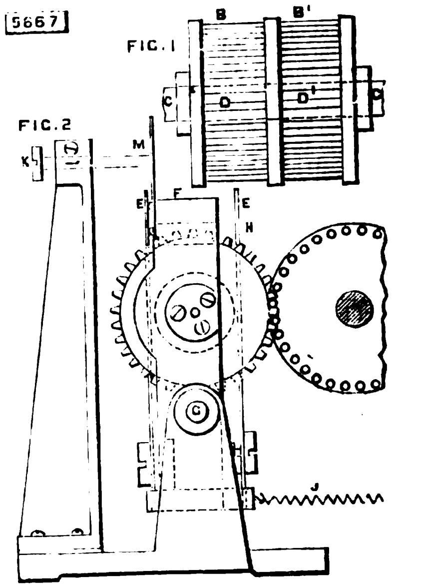


260,652

other suitable conductor. Over these bands are coiled the magnetising-helices in the customary manner, the purpose being to avoid extra currents,

5667. Improvements in Means or Apparatus for the Collection and Distribution of Electric Currents, *S. A. Varley, Hatfield, Herts.—24th December*, 1881. 6*d*.

The object of this apparatus is to avoid sparking at the commutators of dynamo machines. The figures explain one form of the inventor's device. Fig. 2 shows only half the apparatus, the other half being a duplicate of that shown. In Fig. 1 the two pinions B B^1 are mounted on shaft C, and have each a set of pins, D or D^1, each pin being insulated from the others and the cheeks, and being connected to one of the junctions of the coils of the armature. Pins D are set a distance equal to half their pitch in advance

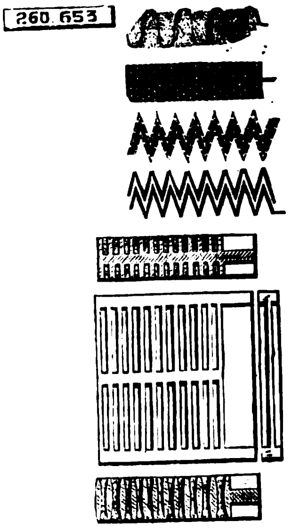


5667 FIG. 1 FIG. 2

of pins D^1. Fig. 2 shows the contact wheels, which constitute the poles of the generator H. There are two contact wheels at each side of each pinion; E are brake springs which keep the teeth of the contact wheels steady. The contact wheels revolve on an axis carried in a frame F pivoted at G. The lower end of this frame is connected to that on the other side by insulated spring J, which tends to draw the contact wheels away from the commutator, while their upper ends carry spring M, adjusted by screw K to force the contact wheels against the commutator.

260,653. Secondary Battery, *C. F. Brush, Cleveland, Ohio.—Filed June* 15, 1882.

Claim.—In a secondary battery, an element consisting of a structure of etagère-like form,



260,653

containing in the spaces between its shelves lead in a finely-divided state, substantially as set forth.

5599. Insulator Conductor, *W. Smith.—31st December*, 1881. 2*d*.

Instead of gutta percha a mixture of gutta percha and zinc white is used.

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SLIP

Meeting.—The next general meeting of the Brazilian Submarine Telegraph Company will be held on the 27th inst., at 2 p.m.

Brazilian Submarine Telegraph Company.—The traffic receipts of this company for the week ended October 13th amounted to £3,842.

New Cable to Western Africa.—According to the Paris correspondent of *The Times*, a cable will before long be laid between France and Senegal.

Electric Light in Troy, New York.—The Common Council of this city have passed a resolution allowing electric lights to be introduced into their streets.

Cable Repaired.—The Eastern Telegraph Company notifies the repair of the Hong Kong-Shanghai cables, thus restoring telegraphic communication with Amoy and Shanghai *viâ* India.

Rates to Valparaiso.—We are informed by the Direct Spanish Telegraph Company that their rate to Valparaiso and other stations in Chili has been reduced from £1 4s. to 14s. 8d. per word.

West Coast of America Telegraph Company.—The fifth Ordinary General Meeting of this Company will be held on Monday, the 23rd instant, at 12:30 p.m., at the Cannon-street Hotel, E.C.

Electric Lighting in Brighton.—The Brighton Town Council have decided not to allow any company to supply electricity in that town, and will consider as to the advisability of supplying it themselves.

London Platino Brazilian Telegraph Company.—The revenue of this company for the month of July, 1882, is estimated at £1,382 (Western Brazilian portion £849, land lines £533), as against £1,658 for the corresponding period of 1881.

Electric Light in Shipbuilding Yards.—The extensive shipbuilding yard, shops, and sheds of Messrs. Pearce, Bros., at Dundee, are to be lighted by means of arc lamps, supplied by the Northern Electric Light Company, of Dundee.

Electric Light at Ebbwvale (Mon.).—We are informed that the Ebbwvale Company have decided to have their works lighted by the Ferranti system, and the necessary work is being carried out by the Hammond Electric Light Company.

Western and Brazilian Telegraph Company.—The traffic receipts of this company for the week ending 13th October, 1882, were £2,527, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

A Conference on the Electric Light.—The Camberwell Vestry have decided to invite all the vestries and boards of works in the south of London to hold a conference on the provisions of the Electric Lighting Act, and the question of electric lighting generally.

The Telephone in Quebec.—The *Colonies and India* says that the Bell Telephone Company is actively engaged in extending its lines in the above city; also that the cable to connect the two sides of the Chaudière river is daily expected, and will be laid at Cape Rouge.

Electric Light in Brazil.—The Brazilian Government has entered into a contract for lighting the town of Campos by electricity. This will be the first town in Brazil that has been lighted by electricity, but it is to be hoped ere long Government will give permission for other towns to follow its example.

Electric Lighting in Liverpool.—Messrs. B. Hyam and Son, of Lime-street, Liverpool, are so satisfied with the Weston arc lamps that have recently been erected in their premises by the Maxim-Weston Company, that they intend to introduce these lamps into their establishments in Manchester, Glasgow, and other towns.

Electric Light in Mills.—The Edison Company, of Boston, U.S.A., have introduced their lights into the King Philip and Conanicut Mills of Fall River. There are 1,080 lamps altogether, and they are said to give every satisfaction. The Amory Mills, of Manchester, New Haven, are also to be fitted with 250 lights by the same company.

Electric Light in Theatres.—The Opera House, at Pittsburgh, U.S.A., was lighted by the electric light September 27. It is stated by the local papers that the lighting was successful, except that the members of the theatrical company did not like the electric light very well. It showed all their imperfections too plainly; the powder and paint were very visible.

Electric Lighting in Dundee.—The Kinnaird and Argyle Halls in Dundee are to be lighted by arc lamps, the *Dundee Advertiser* office by incandescent lamps, and part of Messrs. Lamb and Company's hotel with incandescent lamps. The current for all these lights will be generated from one centre. The work is to be carried out by the Northern Electric Light Company, of Dundee.

Electric Lighting in London.—At the last meeting of the Court of Common Council notice of the following motion was given:—"That it is inexpedient that any further vested interest in the lighting of the City of London should be allowed to arise, and that it be referred to the Gas and Water Committee to bring up a scheme for the supply of electricity by the Corporation or the Commissioners of Sewers."

Electric Light at Leeds.—It is reported that the Corporation of Leeds have asked the principal electric lighting companies if they are prepared to submit to the Corporation, for experimental purposes, tenders for the completion and maintenance for a limited period of an installation of electric lighting in front of the Town Hall, the interior of the building, and certain rooms in the new municipal buildings.

Undertakers and Electricity.—A member of the Kensington Vestry asked the somewhat pertinent question, "What has electricity to do with undertakers?" at a recent meeting. Unfortunately the lugubrious term has become law, and is to be found at every turn in the Electric Lighting Act, 1882. We confess that we are in accord with Mr. William Griffith when he prefers the old term "promoter" to that of "undertaker."

Cables on the West Coast of America.—The length of cables and land lines worked by the West Coast of America Telegraph Company is as follows:—Cables (nautical miles): Valparaiso to Serena, 219·03; Serena to Caldera, 215·34; Caldera to Antofagasta, 229·00; Antofagasta to Iquique, 250·50; Iquique to Arica, 128·35; Arica to Mollendo, 146·42; Mollendo to Chorrillos, 510·08. Land lines: Chorrillos to Lima, 11·00; Lima to Callao, 7·00—1716·72.

A Telephone Cable across the Tay.—We may supplement our note of last week under this heading by the following additional information:—The cable which is to connect the National Telephone Company's Dundee exchange with Tayport and Newport has eight cores of No. 16. copper wires, each covered with a layer of india rubber. The outer

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covering consists of 16 No. 4 iron wires, surrounded by a layer of tarred jute. The whole is bound together with plaited hemp.

Cost of One Horse-Power.—An American contemporary says:—According to the following excerpt from the *School of Mines Quarterly*, the cost of one horse-power per hour is as follows, from experiments lately made at Carlsrhue: 100 h.-p. steam engine, ·95 pence; 2 h.-p. steam engine, 5·50 pence; 2 h.-p. Lehman's caloric engine, 3·31 pence; 2 h.-p. Hock motor, 1·00 pence; 2 h.-p. Otto gas engine, 3·26 pence; 2 h.-p. Otto-Langen gas engine, 3.26 pence; 2 h.-p. Schmidt water engine (fed by city water supply), 11·87 pence; horses, 25·00 pence; men, —.

Another Edison Station in America.—The Edison Company are establishing a plant at Roselle, N.J., for lighting from a central station now being constructed at the corner of Locust-street and First Avenue (near the Central Railway Station), from which wires will be run on poles to the houses. Engines of 150 horse-power will be used, capable of furnishing 3,000 lights. The buildings to be lighted are mostly private dwellings. This is the first undertaking of the company to light a district from a central station outside of New York city.

Electric Lighting in Trains.—The Pennsylvania Central Railroad Company have been making experiments in lighting some of their trains by means of Edison lamps supplied with current by Faure accumulators. The lighting is being carried out under the direction of Mr. Lachlan, the electrician, who superintended the introduction of the light into the cars of the London, Brighton, and South Coast Railway Company. If the experiment proves a success it is the intention of the company to introduce this system of lighting into several of its trains.

Electric Lighting in Islington.—According to a recent report of the Islington Vestry, the cost of lighting Upper-street, in this district, with gas is £222 per annum. The Jablochkoff Company offer to light it by their system for £547 10s. per annum, to include all the necessary works. The Sun Lamp Company would light it at the same price as gas, if they were granted a license to light this street for 21 years. The Metropolitan Brush Company would light the street for £550 per annum, on condition that they are given the contract for three years. The Vestry have taken time to consider the question.

Electric Light in Ironworks.—The electric light has been introduced into the works of Messrs. James Goodwin and Co., iron founders, of Motherwell, in Scotland. The mode of its introduction as revealed by a provincial contemporary is somewhat startling. The paper in question says:—"The electricity was placed on a pinnacle of the works in Park-street, and not only lighted the whole departments of the work, but shed a clear light in Park-street and Merry-street, and the surrounding neighbourhood." The sight of electricity "placed on a pinnacle" is one not often permitted to ordinary mortals, but then newspaper reporters, particularly Scotch newspaper reporters, are so far-seeing as to take ken of things beyond an ordinary mortals' vision.

English Delegates to the Paris Congress.—*The Times* Paris correspondent telegraphs, under date October 15, as follows:—"Mr. Kennedy, of the English Foreign Office, Colonel Champain, representing the Government of India, Mr. Patey, of the English Post Office, and Mr. Trevor, of the Board of Trade, have arrived in Paris as the British Indian delegates to the Conference for the Protection of Submarine Telegraphs, which is to be opened to-morrow. These nominations have given satisfaction. Mr. Kennedy has been employed in all the commercial negotiations since 1871. Colonel Champain and Mr. Patey have attended previous telegraphic conferences, and Mr. Trevor conducts the business relating to telegraph companies in England."

Electric Lighting in Glasgow.—At the annual meeting of the Glasgow Institute of Architects, held on Tuesday last, the president, Mr. John Honeyman, made some remarks on the proposal of the gas committee of the corporation to debar all and sundry from supplying electricity in that town, in order that they might secure a monopoly to themselves. Mr. Honeyman expressed his conviction "that if the citizens allowed the corporation to act on the recommendation of the gas committee, they would, ere long, heartily repent of it. It seemed to him a monstrous thing that at this time of the day they should, without a word of protest, allow themselves quietly to be fixed down under the incubus of a monopoly, which must inevitably paralyse local enterprise and drive an important industry from the city."

Electric Light in Ireland.—We noticed a few weeks ago that the well-known shipbuilders, Messrs. Harland and Wolff, of Belfast, were about to adopt Crompton and Company's system of arc lighting permanently. The plant, consisting of Bürgin machine and Crompton lamps, was set going about three weeks ago, and works very satisfactorily. Mr. A. R. Walker, of Newry, has his new and extensive flour mills and offices illuminated with Swan's lamps, the current being supplied by Crompton's shunt-wound Bürgin machine. We understand Mr. Walker is so pleased with the light that it is to be extended to his other mills. The work in both these cases has been carried out by Mr. J. H. Greenhill, of Belfast, who may be congratulated upon the success attending his labours. He has been entrusted by Messrs. Guinness, Son, and Co. to introduce Swan's lamps and Crompton's machines into their new premises at Kingsbridge, Dublin.

Overhead Wires.—The question of the wires has brought to light an unexpected orator in a member of the Marylebone Vestry. In moving a resolution requesting the clerk to report on the question of the power of the Vestry to prohibit the erection of overhead wires, this gentleman made use of the following eloquent, though somewhat involved, language. He said:—"In consequence of the various dangers of the street every year a holocaust of human lives was offered as a sacrifice to the divinity that governs the streets of this metropolis. There was, at least, one life slain by the sudden snapping and breaking of a wire overhead, suspended between heaven and earth." Perhaps the reporters are in error, but the contrast between a "holocaust offered as a sacrifice," and "one life slain," is rather marked. Possibly, however, what is meant is, that a holocaust is *offered*, and may some day be accepted; in that case we are inclined to agree with the vestryman.

The Electric Light and Riveting Work.—Mr. Ralph H. Tweddell, in order to facilitate the working of his portable riveting machines at night, attaches Swan's incandescent lamps to them; the flexible copper tubes conveying the hydraulic pressure to the machinery afford a convenient support for the conductors of the electricity, and enable the lamps to follow all the movements of the riveting tool. The effect of this novel application is very good, and the advantages are well illustrated by its application to one of Mr Tweddell's hydraulic keel-riveting machines, shown by Messrs. Fielding and Platt, of Gloucester, at the Tynemouth Exhibition. This keel riveter, says the *Newcastle Daily*

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Chronicle, is shown at work under the bottom of a ship, and consequently in a very dark situation. At the same stand another lamp is attached to a portable riveting machine and hydraulic lift. This lamp, in connection with such a machine, can be applied at any required point over a floor area of 1,200 superficial feet, and with a vertical range of 20ft., without having any new connections to make either in the hydraulic or electrical power transmitting apparatus.

Electric Light in Breunn (Austria).—A correspondent sends in some further information relative to the introduction of the Edison system into the new theatre at Breunn, to which we alluded in a recent note. The number of lamps that will be fitted up is 1,600 (16 candles), though only 1,000 of these will be in use at the same time. All the stage lights will be regulated by the introduction of resistances, so that their intensity can be reduced at will. Arrangements have also been made by which different coloured lights—red and green—can be thrown where required. The current will be supplied by four Edison K dynamos, similar to the one illustrated in our issue of the 14th instant, situated about 379 yards away from the theatre, and conducted underground by the ordinary Edison conductors. The field magnets will be excited by a Gramme machine. Two separate lines of conductors will also lead to the theatre, the one carrying the current for 5 arc lights (Gramme system), placed in the square outside the theatre, and the other carrying the current used to actuate a Gramme machine, which drives a ventilator in the theatre. The work is being carried on under the superintendence of Mr. Francis Jehl, of the Edison Company in Paris.

Death of Mr. Sanger.—We regret to have to announce the death of Mr. Thomas H. Sanger, late divisional engineer of the Telegraph Department of the General Post Office in Ireland. Mr. Sanger died on the 14th inst., after a long illness, at his residence, 8, Belgrave-square, Monkstown, at the age of fifty-three. As showing the universal esteem in which he was held we take the following extract from an Irish paper:—"Mr. Sanger had been for many years the head of the Government telegraphic department of the General Post Office in Ireland, and by his intelligence, courtesy, and intimate knowledge of the duties of the most important position which he occupied, earned for himself the high esteem and confidence of the public. In private life Mr. Sanger was held in much regard, and his premature demise at a time when it was to be hoped that he would long enjoy the honourable retirement which he so well merited has caused widespread and sincere expressions of regret. The flag of the Royal Irish Yacht Club was hoisted half-mast high in respect to his memory. None will more deeply deplore the demise of Mr. Sanger than the numerous officials in the telegraph service in Ireland, to whom he was always kind, generous, and considerate."

The Electrical Congress in Paris.—The international congress held with the object of establishing uniformity in the terms and units of electric science, as well as a uniform method of observation, was opened at the Paris Foreign Office by M. Duclerc, President of the French Cabinet, on Monday last, the 16th instant. In his opening address M. Duclerc thanked foreign governments for having sent illustrious *savans* as delegates, and expressed the interest of France in the solution of a problem which would not merely enlarge the field of human knowledge, but facilitate scientific research and pave the way for admirable discoveries, powerfully contributing to human progress. To specify the methods of observing atmospheric electricity and of studying earth currents would insure the more effective and less perilous use of electricity, and he was happy to see the French metropolis selected as the scene of the labours of the Congress. M. Cochery, Minister of Posts and Telegraphs, was then elected President. The other French delegates are MM. J. B. Dumas, Jamin, Clavery, Bergon, Blavier, and Mascart. The names of the German and English delegates were given in a note in our last issue.

Cable Protection.—The Congress on the question of protection for submarine cables was opened in Paris on Monday last, the 16th inst., by M. Duclerc. In his opening speech the President of the Republic dwelt upon the importance of the subject. Submarine cables, he said, which now measured sixty thousand nautical miles, and represented capital to be computed by hundreds of millions sterling, were at the present time in a more unfortunate position than the most insignificant production of human labour and enterprise, since they were absolutely without any legal protection. The object of the deliberations of the Conference would therefore be to determine the responsibilities and liabilities in relation to breakage or damage to cables in the high seas, to indicate the measures necessary for the safety of vessels engaged in laying or maintaining the cables, and to fix the respective rights of different proprietors of cables on the same line. The Conference was afterwards addressed by M. Kern, the Swiss delegate, and M. Cochery, Minister of French Posts and Telegraphs, on the importance of the object aimed at. The programme for the next sitting was then settled, and the Conference adjourned. The French delegates are MM. Cochery, Dumas, Clavery, Bergon, Renault, and Captain Dupont.

An Early Gas Engine.—In looking over an early volume of the *Scientific American*, we find in the issue of July 23, 1846 (thirty-six years ago), the following description of a gas engine which had just been invented, and which, the article says, might have been seen at the store of Samuel Perry, in Front-street, near Whitehall, in this city. This was probably one of the earliest gas motors constructed:—"The machinery consists in part of a cylinder, piston, pitman, flywheel, and governor; in this respect similar to a steam engine. A small quantity of spirits of turpentine is kept in a warm state, and the vapour arising therefrom is mixed with fifty times its volume of atmospheric air. A small quantity of this hydrogenated air is drawn into the cylinder, and ignited by a movement of the machinery, producing a slight explosion, whereby the remaining air—at least nine-tenths of the whole—becomes so heated that it drives forward the piston with great force. This engine is said to be capable of working 10 horse-power, and it is intended to substitute rosin instead of turpentine, which will reduce the expense of feeding it to about 50 cents per day. The ingenious inventor has had some difficulties to encounter in the construction of the first engine, but has a fair prospect of being well remunerated for his labour."—*Scientific American.*

A New Incandescent Lamp.—We have been much interested in examining a new candidate for public favour in the way of an incandescent electric light, says the *Boston* (U.S.A.) *Journal of Commerce.* We refer to the one manufactured by the Bernstein Electric Light Manufacturing Company, of 41, Arch-street, Boston. This light has some especial features, was patented in June, 1882, and is based on entirely different principles from all the patented systems of incandescent lamps. It is unlike the Edison, Swan, and Maxim; where each of these use a very delicate carbon filament as a light-giving body (and these filaments do not withstand the action of strong currents of electricity, but are easily destroyed, and economy in an incandescent system of

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lighting is obtained by an application of a strong current), in the Bernstein lamp, the light is given out by an unfusible and insulating material which has been covered with a deposit of carbon having the shape of a cylinder. This lamp, the Bernstein, gives a very brilliant light, which can be regulated or graduated just as appears desirable or necessary. Lamps of different powers are furnished as desired, and any kind of dynamo machine may be used to furnish the current. The company are preparing a new dynamo of their own, and will soon be ready to offer the complete system to manufacturers. They have already had considerable orders for their lamps, and are now sending them to Germany. They have had numerous inquiries for the United States, and have now orders for nearly or quite 6,000 lamps which will be furnished as soon as they can be manufactured, and the manufacture is now going on.

A Dutch Village Fired by Lightning.—A correspondent of *The Times* writes:—"The passengers from Antwerp to Harwich on the Great Eastern Railway Company's paddle steamer 'Pacific' on Wednesday night (October 11) witnessed a scene which was awful in its grandeur. The boat had left Antwerp at 4:30 p.m. in bright, warm sunshine, but after travelling down the river Scheldt to a point about midway between that city and the island of Walcheren, on which the well-known landing stage of Flushing is situated, the very unusual phenomenon, in October, of a thunderstorm came on, and the drenching rain soon cleared the decks. At 7 p.m., however, a group of two or three passengers and the ship's carpenter stood chatting at the smoke-room door when they observed a more than usually vivid flash of forked lightning in the horizon, which had the appearance of a huge obelisk of fire, the light from which revealed a plantation of trees with a village in the rear. Almost instantly, what appeared to be the whole, and must have been a large portion, of the village was in flames, and an immense lurid glare lit up the country around, while the village church bell tolled out its mournful signal of distress. The crew of the boat and some of the Dutch passengers indicated the village of Wrlsoorden, on the south bank of the Scheldt, as the scene of the conflagration, and as there were at least three other fires of less dimensions raging contemporaneously in the surrounding country, all parties believed that they were the result of the fierce storm of lightning, which raged for two hours, and which was unrivalled in the experience of the crew and passengers alike."

Electric Light and Gas in New York.—The New York Gas Company light the district occupied by the Edison Company, and we may take this gas for comparison with the "new light," says the *Sanitary Engineer.* The gas in question has a high specific gravity, about ·760, and ordinary argands will burn between 4ft. and 5ft. per hour. The better class of flat-flame burners, such as are used in the Edison district, consume from 4ft. to 6ft. per hour, and are better adapted than the argands to burn gas of the quality furnished. For comparison, we can safely say that the gas burners used by persons likely to employ the incandescent lamp, will burn 5ft. per hour. The report of the gas examiner for the three months ending June 30, gives the average illuminating power of the New York Company as 12·16 candles. That is, a burner consuming at the rate of 5ft. per hour will give the light of about 22 candles. The standard Edison lamp gives the light of 16 candles, although lamps of 20 or 32 candles can be furnished if desired, but at a greater expense to the consumer. These figures as to the illuminating power of the incandescent lamps are the company's estimate of their value, but before long independent determinations will doubtless be made. Taking the company's figures, then, we have an incandescent lamp of 16 candles in place of a gas burner of 22 candles. It is hardly to be wondered at, therefore, that consumers who have been using ordinarily good gas burners should complain of an insufficient amount of light. At present gas consumers are paying 2·25dols. per thousand cubic feet, which is equivalent to $1\frac{1}{8}$ cents. per hour for a light of 22 candles. Moreover, competition may reduce the cost to $\frac{3}{4}$ of a cent. per hour. Will the Edison Company furnish a lamp of even 16 candle-power for this amount? In other words, can the incandescent lamp compete on a commercial basis with gas, light for light? That is the problem to be solved. In the future, therefore, electric lighting Bills will be of considerable interest. The incandescent lamp certainly has some advantages over gas, and we wish the new comer success, both on its own account and also in the hope that by competition the price of gas may be reduced and its consumption increased.

The Origin of Thunderstorms.—In a recent paper to the Belgian Academy, M. Spring takes exception to the prevailing theory as to the genesis of thunderstorms, according to which the air yields its electricity to the vesicles of the forming thundercloud, which also acquires electricity through the act of condensation; the electricity accumulates at the cloud's surface, and when the cloud comes near another oppositely electrified, or near the earth, there may be recomposition of the two electricities, with lightning and thunder. It is objected that all the vesicles must take the same electricity, and should so tend to disperse. One cannot speak of the surface of a cloud as of a metallic conductor; its surface presents a gradual transition. Further, in view of the poor insulating qualities of moist air, how is the tension capable of producing sparks several leagues long to be accounted for? And, once more, no production of electricity has ever been observed experimentally, during condensation of aqueous vapour. From some recent Swiss experiences, M. Spring has come to form a different theory. In a hut on the Urnenal (at a height of 2,198 metres) he experienced a violent thunderstorm one night. There was for about half an hour terrific hail, without a single drop of rain, and whenever the hail grew momentarily more intense a vivid lightning flash occurred, and at the same moment loud thunder, like the report of a powerful cannon. The travellers were evidently at the very heart of the storm. Before long some rain-drops began to fall, and as they increased the flashes and peals became less and less frequent. Now, M. Spring's idea is as follows:—Each hailstone, of whatever size, is the result of union, by regelation, of many crystals of sleet. In this process an enormous free surface disappears in a body that is a non-conductor of electricity, viz., ice, and in presence of another non-conducting substance, viz., dry air. Experiment leads us to expect in such a process a large development of electricity, and to this has to be added electricity arising from friction of the hailstones with the air. Thus we have a large number of electrified spheres near each other, and separated by an insulating medium; and those, forming in some sort the surface of the region, should, according to Faraday's researches, acquire an electric charge equal to the sum of the charges of the central spheres; hence enormous electric tension in that superficial part, relieved from time to time by discharge between the hailstones and the air or the ground. M. Spring supports his view by a variety of facts observed both in Alpine regions and in the laboratory, but for these (says *The Times*) we must refer to his paper.

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ELECTRICAL REPULSION.—II.

BY J. T. SPRAGUE.

(CONTINUED FROM PAGE 357, VOL. VIII.)

We can form several distinct conceptions of "fields of force," either dynamic or static. Of the dynamic order we have excellent examples in the diagrams illustrating the experiments of Bjerkness and of Stroh, where the one in water and the other in air show results mechanically produced closely analogous to the attractions, repulsions, and motions due to both electricity and magnetism. Such fields are essentially composed of regular circulating currents. The static field of force involves an effort of the imagination. It exists in the case of induction (so called) in dielectrics, and around every electric current; it exists also around every magnet, as the magnetic field which can be given a partial objective and visible form by the assistance of iron filings, as is commonly practised. The lines formed by such filings show us plainly enough that there is some agency outside the magnet capable of ranging surrounding matter in a definite order, and they show that this agency is "static;" it involves no motion and no expenditure of energy, which would be a necessary accompaniment of motion under such circumstances. But the information they give is very crude, because the ultimate action is not one of visible particles of matter but of the invisible molecules. Here the imagination has to work out their teaching.

We see first, then, that the nature of a field of force is such that it tends to range the molecules of every substance which enters it in a definite systematic order which we call polar, the character of such polarisation in each case depending upon the nature of the force to which the field belongs.

Secondly, whenever two such fields of force approach each other so as to exert a mutual influence, it is evident that they will each tend to appropriate and assimilate each other's constituent molecules. If one or both fields be capable of motion it is evident that one of two events must happen. 1. The two fields will combine into one. 2. The stronger or the fixed one will drive the other out of its own range in the line of least resistance.

The actual constitution of magnets is an example of the first of these actions. We know that a magnet is composed of minute particles (into which it may be divided), each of which is a perfect magnet. These all place themselves in polar order, and as a consequence transfer their individual actions to their exterior rows, and unite their individual fields into one, the size and intensity of which depends upon the number and mode of arrangement of the constituting particles or ultimate magnets, and upon the degree of magnetic intensity possessed by them individually. The act of magnetisation, however effected, involves the charging upon and absorption by these molecules, alike of the magnet and its field, of energy which remains there, stored potentially in the form of this molecular strain. Such a static strain involves a closed circle. We cannot exert a strain upon a rope unless it is fixed; if we have a number of spiral springs, for instance (which may assist the conception of molecular interactions), we cannot store energy in them by strain unless they are fixed; if we link them together, and fix the ends of the chains, we can strain them. This idea, therefore, must necessarily be transferred to the field of force. A magnet shows us two such sets of circles. The effects of electric currents in producing magnets show us that there is some action distinct from the N and S polar order of the magnet itself: This action is embodied in Ampère's theory of molecular currents combining so as to result in a current circulating around the axis of the magnetic system. This conception is shown in Fig. 1, where N is the face of one end of the magnet, and S is a longitudinal view showing the supposed electric currents. In Fig. 2 is shown in like manner the theory I suggest as more accordant with the static nature of magnetic force. The molecules are shown as forming strained or polarised circles around the magnet. The idea is in all respects the same as Ampère's, with the substitution of static polarised circles, replacing circulating currents. But this only covers one aspect of magnetic force, because the electric and magnetic polar lines are at right angles to each other. In Fig. 3 I have endeavoured to illustrate this by showing a molecule forming part of a current (or of a static charge) + –, while the arrows crossing it represent lines of magnetic force. This representation is, however, imperfect, because these magnetic lines have no

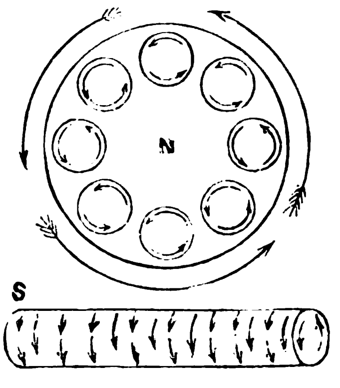

FIG. 1.

real direction in the case of a straight electric circuit, but the figure is also intended to show the relative actions of currents and magnets; for a current passing from + to — over a magnetic needle deflects it, as shown N S. Fig. 4 also shows in B and C the two conceptions of a magnetic filament or series of particles. B shows the old or physical idea of the

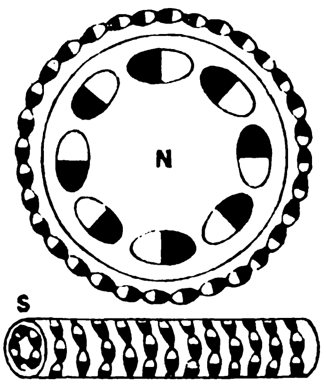

FIG. 2.

constitution of the magnet as built up of a series of infinitesimal magnets arranged in polar order; while E shows the molecules themselves, arranged transversely around the magnet, with their lines of magnetic force coalescing in the axial line. The small arrows also show the direction of the current which would generate this magnetism.

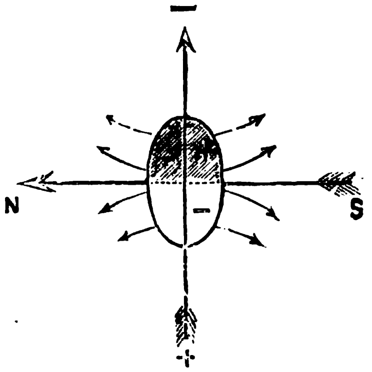

FIG. 3.

We must now take into consideration a general law of inductive action—known as Lenz's law—in some of its aspects, viz., that induced actions are opposed to the inducing actions. We may aid the imagination in conceiving this by considering the relations of two wheels in contact; the motion of one induces motion in the other *in the reverse direction.* It is

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the same with static charges and with electric currents. It is the same, also, when a magnet induces magnetism in a magnetic substance. We see this when a piece of iron approaches a magnet. We conclude, therefore, it is the same with other substances in which the polar conditions are less manifested,

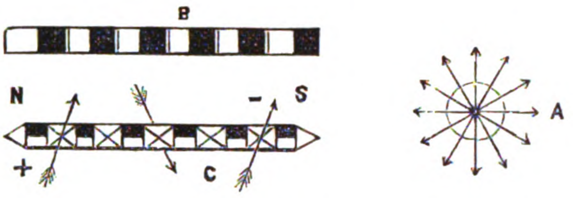

Fig. 4.

and we find, in fact, that the magnetic order of the *external* field is in a direction *opposed* to the direction of the magnet itself. With the aid of this perception we can construct the complete system of magnet and field, as shown (Fig. 5).

Now, if we consider the magnet and field separately, it is evident that the lines of force would be in the form of cylinders. Why, then, do they turn into ellipses, as we see they do when we examine them by aid of iron filings. Looking at the magnetic bar alone, and with their minds charged with the idea of the self-repulsive nature of electricity and magnetism, and influenced by the theories devised before the intimate connection of electricity and magnetism was discovered, philosophers have devised the explanation that the parallel lines of force issuing from the magnetic poles (as shown by the arrows) being self-repulsive, immediately spread out, and ultimately meet the lines from the other pole, for which, furthermore, they have an attraction. But no repulsive force is necessary. The circular electro-induced system around the magnet and its lines of magnetic force everywhere present themselves to those of the magnet, and constitute a closed system, a field of force in which the energy is distributed according to the magnetic capacity of the molecules within its range.

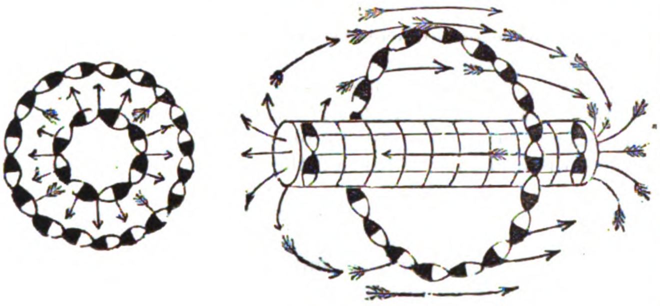

Fig. 5.

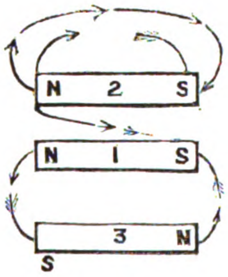

Fig. 6.

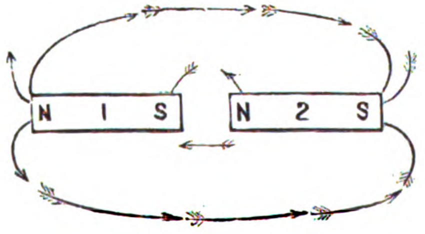

Fig. 7.

When two such systems approach each other, both sets of lines intermingle, and take possession of the space and contained matter, and in Figs. 6 and 7 the result is apparent.

The megnetic lines only are shown in these figures, to avoid confusion. In Fig. 6, N S 1 is a magnet, to which approaches N S 2, with poles similarly placed. It is evident that, if they are equal, the intermediate space becomes neutral, and that the least variation from parallelism must set up a line of magnetic force diagonally across their opposite poles, tending to pull the movable arc round on its axis.

If the opposite poles are presented as with N S 1 and 3, the lines of force at once coalesce, because of the greater magnetic capacity of iron or steel over the air, which, therefore, enables the metal to absorb the energy while constituting a magnetic field or circuit of lower resistance. The same actions draw the bars together until the external field is nearly absorbed by the two bars uniting in a closed circuit. There always remains a small external action, because there is not perfect molecular contact; but a ring of homogeneous steel may be highly magnetised, and will show no magnetic actions, because the circuit is internal. But saw the ring across, and the two poles will manifest themselves of equal strength wherever the ring may be opened. In Fig. 7 the two bars are shown, presented end to end with opposite poles facing. Then the same causes neutralise the near poles, while the distant ones manifest increased magnetism. The result is attraction in all directions, and the fields coalesce into one, exactly as in Fig. 5. Thus it is clear that, although magnetism is the strong fortress of the "repulsive force," and repulsion experiments are so common, yet, when examined, all these effects of apparent repulsion resolve themselves into the effort of fields of force to range themselves in symmetrical order and unite themselves in one. The idea of any repulsive force or action is absolutely uncalled for. All the actions, attractive or repellent, are due simply to the greater or less capacity of matter to absorb the energy in a special manner and to constitute from lines of force complete closed systems in which the energy is stored.

TATE'S PATENT ELECTRICAL STOP VALVE CONTROLLER.

The accompanying engraving shows an apparatus used for stopping engines in case of accident, now being introduced by Messrs. Duncan Brothers, Queen Victoria-street. It consists of an ordinary Leclanché battery, an electro-magnet, the wires leading to any position from which it may be desirable to control the engine, and buttons for completing the circuit. Also a small steam cylinder, piston, and rack and pinion gearing, which actuates the stop valve on the engine. An electro-magnet is placed at the top of the apparatus, and connected directly to a suspension rod which actuates a small steam cock on the cylinder, seen at the side of the stop valve. The circuit is an open one, and when it is desired to put the apparatus in operation the pressure of the finger on one of the buttons—at any distance from the engine—closes the circuit and excites the electro-magnet, the effect being to release the suspension rod, which falls with a velocity due to gravity. The suspension rod in falling opens the small cock on the cylinder and admits steam, the initial pressure of steam being the same as in the steam engine cylinder. The piston in the cylinder of the apparatus immediately ascends, and the rack piston rod then closes the engine stop valve. The steam to work the apparatus being taken from the stop valve chamber from underneath the valve—*i.e.*, between the valve and the steam engine cylinder—the consequence is that as soon as the stop valve has been closed there is no longer any pressure in the small cylinder; and when it is desired to start the engine, the engine driver has simply to lift up the suspension rod to its normal position and open the stop

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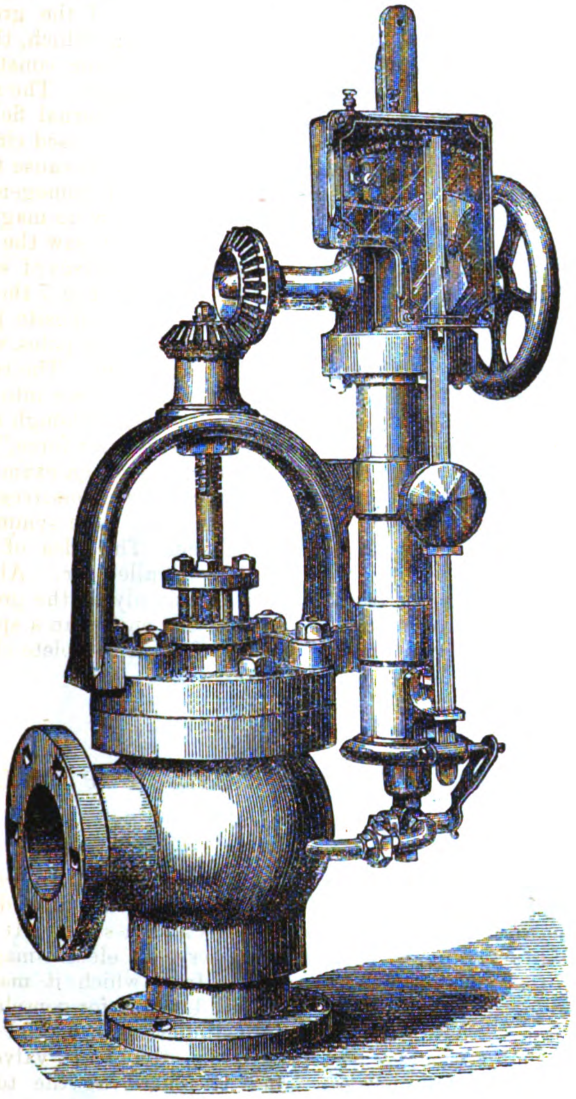
valve in the ordinary way. In lifting the suspension rod the small cylinder cock is again closed against the admission of steam, but the cock having three passages is opened for the inlet of atmospheric air. The act of opening the stop valve by the hand wheel operates also on the piston, which falls to the lower end of the small cylinder and is then reset for further use. When applied to the stop valves of condensing engines, a cock fitted on a pipe opening to the atmosphere is also actuated by the apparatus, and at the instant the stop valve is closed this cock is opened, thus admitting air into the condenser, destroying the vacuum and stopping the supply of water. The apparatus also stops the engine on which it is fitted whenever the speed



Tate's Patent Electrical Stop Valve Controller.

exceeds the ordinary rate by any given number of revolutions. This is effected by means of the throttle, or variable expansion valves, actuated by the engine governor. Short arms are fixed on the valve spindles which act as fingers to press in a push, or button, at any time the valve exceeds the usual range of lift or stroke. In all cases the apparatus resets itself when the engine is started. It will be seen that by placing buttons in suitable places the engines may be started in any room in a large factory. It would apparently be easy to make a small addition by which in the case of a governor strap breaking, steam could be immediately shut off, and so running away would be prevented.

Electric Light in Melbourne.—News from Victoria says that the Australian Electric Light Company have obtained a contract for lighting the Eastern Market in Melbourne. This company work the Brush system.

ELECTRIC LIGHTING.

The following letter from Dr. C. W. Siemens appeared in *The Times* of 17th inst. in reply to one from Mr. Mossop :—

"Sir : Mr. Charles Mossop, in addressing you under the above heading, has more than once made reference to the evidence I gave some months ago before a Parliamentary Committee regarding the cost of establishing the electric light in populous districts. He says :—'No doubt great strides have been made in three months, but it is difficult to understand that the figures then given—£100,000 per centre and a cost of £22,000 annually—have so nearly disappeared.' Mr. Mossop has correctly quoted the figures I gave before the committee, only in a previous letter of the 28th ult. he made me attribute them to a district of one square mile area, whereas I distinctly stated that they were the estimated amounts appertaining to one quarter of a square mile only of a densely populated and well-to-do neighbourhood. They were based upon the results of actual and somewhat extensive experience, and on the assumption that the electric light was to take only a minor share in the total illumination, leaving still to gas all ordinary domestic uses. Nor do I know of any very recent discovery of a character likely to affect these figures.

"It is true we have been told lately of a new dynamo machine in which iron in the rotating coil is dispensed with, and which is said to be capable of developing a light of 2,000 candles with an expenditure of three-fourths of an indicated horse-power. In testing these results by the dictates of science, I find they exceed considerably the utmost limits that could possibly be attained with a dynamo machine and lamp of ideal perfection, and must therefore be regarded as chimerical. But, although the new patent has not yet been specified, enough has transpired regarding its character to enable me to judge of its real capabilities. The inventor has been until recently employed at my works, and the machine with which he proposes to revolutionise the world is only a modification in minor details of the Siemens alternate current machine, which is largely used, and which completely embodies the much-vaunted quality of the absence of iron in the rotating coils.

In conclusion, Dr. Siemens so far from regretting the want of readiness shown by local authorities in granting licenses and procuring provisional orders, thinks "that real progress would be very much retarded by the granting of such applications without reserve."

In reply to Dr. Siemens's letter, the following appeared in *The Times* of the 19th inst. from the solicitors of the Ferranti Company :—

"Sir : We are surprised to find that he (Dr. C. W. Siemens) refers to the new machine of the Ferranti Company as invented by one of his *employés*, and only as a modification in minor details of the Siemens machine.

"We express our surprise, as Mr. Siemens knows perfectly well that the alternating current machine to which he refers is the invention of Sir William Thomson, and that its mechanical details only are covered by the patent of Mr. Siemens's late *employé* and a friend.

"This machine is a distinct type in itself, perfectly unlike any other machine, and its inventor, Sir William Thomson, is acting directly with the Ferranti Company.

"Mr. Siemens implies that it is derogatory to Mr. Ferranti to have been in his employ, but if this is a disadvantage to any one, it is a disadvantage under which Sir Wiliam Thomson does not rest.

"It is only necessary to refer to one other point in Mr. Siemens's letter. He misquotes the statement contained in the pamphlet of the agents of the company, which is that three-fourths of one horse-power is expended for every ten ampere light about 2,000 candle-power 'nominal,' which nomenclature has been adopted by our clients, in common with the other companies, in order to be able to readily compare the amount of work done by the respective machines. The term nominal, omitted by Mr. Siemens, would have perfectly explained the amount of work done to any one conversant with electrical science."

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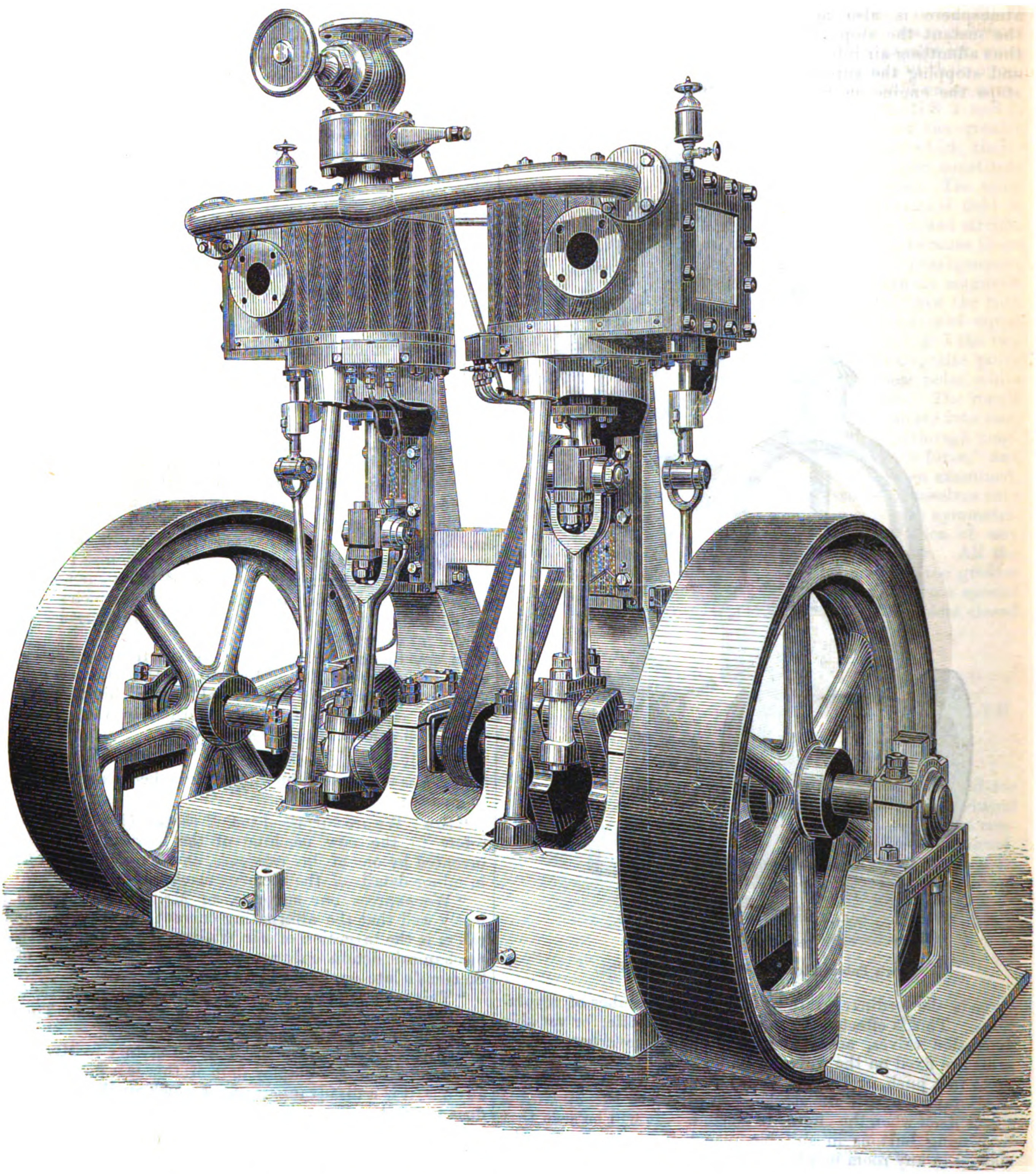
ELECTRIC LIGHT ENGINES.

We herewith illustrate a pair of self-contained vertical engines constructed for driving electric light machines by Messrs. W. H. Allen and Co., of York-street Works, Lambeth, for the Spanish Government. The engines have been made to occupy the least possible space, and to form as compact a machine as possible. The cylinders are 9in. diameter by 8in. stroke, and intended to work at 300 revolutions per minute with a pressure of steam of 80lb., when they will indicate 100 horse-power. The cranks, which are of the best selected steel, are placed at right angles, and are bolted together in the centre, having the balanced weights forged on solid; this coupling forms the pulley for driving the



Electric Light Engine for Spanish Government, constructed by Messrs. W. H. Allen & Co., Lambeth.

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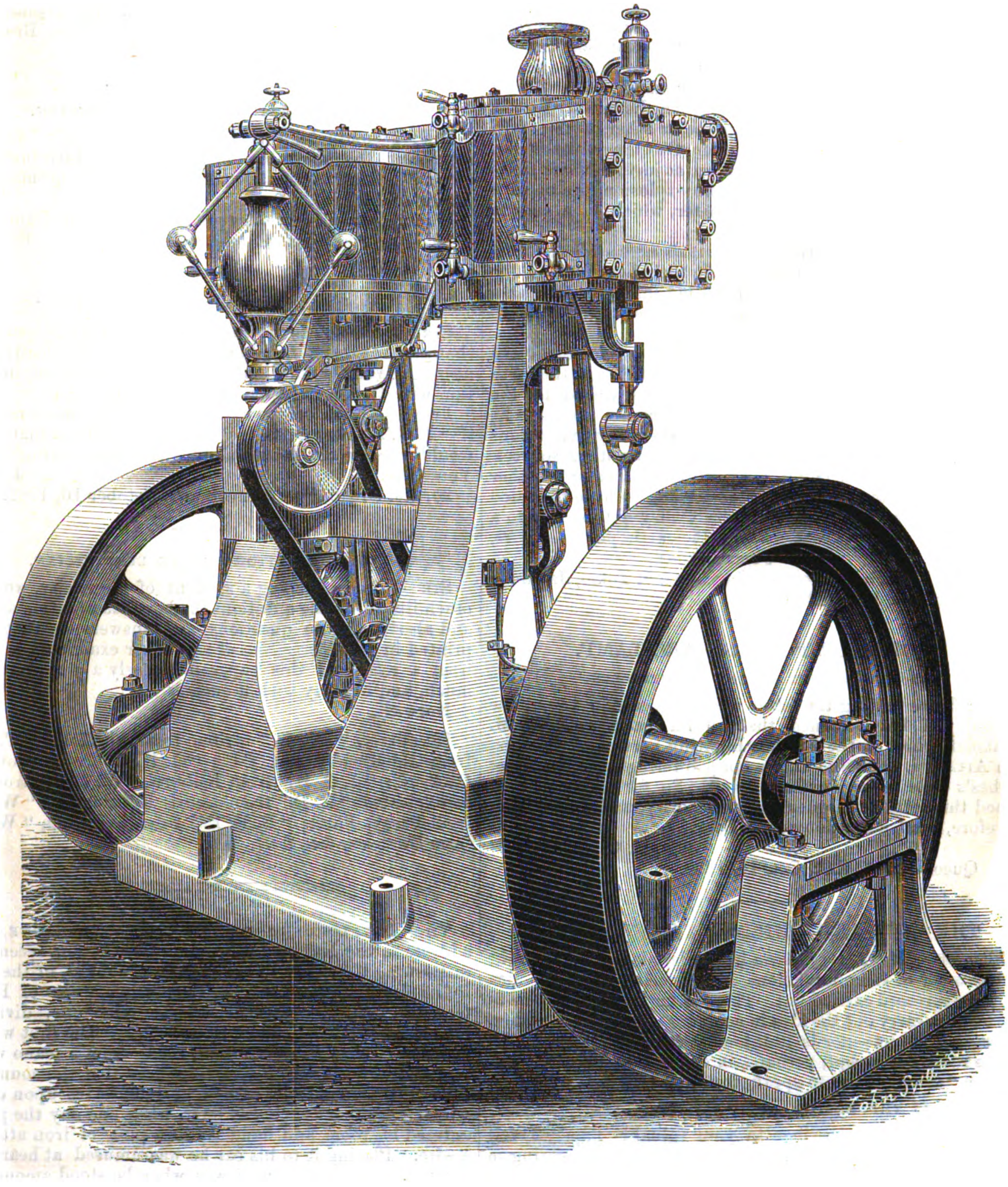
governor. The cranks are supported by six bearings of manganese bronze, each 5in. long. The fly-wheels, which are turned all over inside as well as outside, having a counterweight cast out, are so arranged as to exactly balance the ing the valve extremely sensitive. The arrangement of the engines is good, and they are specially suitable for working on board ships, or in limited or underground spaces where electric lighting machinery often has to be placed. In the



Electri Light Engine for Spanish Government, constructed by Messrs. W. H. Allen & Co., Lambeth.

whole of the working parts, thus securing a very steady movement. The two engines are connected by one copper steam-pipe, upon which is placed the throttle valve. This valve works upon two fine centres without bearings, render- present instance these engines are designed to supply the power required for lighting the electric lamps in the War Office and streets leading thereto at Madrid. They are capital examples of good workmanship.—*Engineer.*

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CORRESPONDENCE.

EARTH MOVEMENTS AND EARTH CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following note may be of interest to the readers of *The Electrician*:—

In the course of a series of experiments on the transmission through the earth of elastic vibrations, produced by the explosion of dynamite (in which I was assisted by Mr. T. Fujioka, of Japan) I had occasion to use in an electric circuit two earth plates, one near the seat of the explosion and the other at sufficient distance not to be sensibly affected by the explosion. A Clark galvanometer was placed in circuit and situated so as not to be disturbed by the vibration. By raising or lowering one or other of the earth plates it was possible so to arrange them that the galvanometer showed no deflection. When such an adjustment was made it was found that in most cases the explosion produced a sudden deflection in the galvanometer, which to a certain extent remained permanent.

It would appear from this that disturbances such as earthquakes or tremors taking place in the neighbourhood of one of the earth plates and not at the other might be the cause of many of the earth currents which so frequently disturb land lines and cables.

It was also found that stamping near one of the earth plates was sufficient to produce a sensible change in the earth current. From this it would seem that plates used for the purpose of obtaining registers of earth currents ought to be placed where they cannot be disturbed by vibrations originating from passing trains, carriages, or other sources. Experiments are now being arranged to determine whether the earth currents which appear sometimes to have preceded earthquakes by considerable intervals may not be due to a strain in the earth's crust around the earth plate.—Yours, &c., JOHN MILNE,

Imperial College of Engineering, Tokio, Japan.

Glasgow, Oct. 11, 1882.

PROFESSOR FORBES'S ARC LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Since writing the letter which appears in your issue of to-day I have learned that so far back as 1874 M. Tchikoleff, chief of the Electric Lighting Service of the Russian Artillery, exhibited an arc lamp differing from Professor Forbes's only in mechanical detail. So far as I am concerned this settles the question of priority, and I shall not, therefore, further trouble you.—Yours, &c.,

ARCHD. C. ELLIOTT.

71, Queen-street, E.C., Oct. 14, 1882.

THE CITY AND GUILDS EXAMINATIONS.

[The letter of "J. G.," given in our last issue, has brought us a number of communications, each desiring to see the idea therein expressed carried out. There is nothing left for us to do except to carry out the idea in accordance with these wishes. We cannot insert—nor is it intended we should insert—the letters received, except, perhaps, in one or two instances, but we give "samples," so to speak, from the bulk.]

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As a new subscriber to your valuable paper, I felt very much indebted to "J. G." for his letter appearing in your edition of last week.

Other subjects come and go, new subjects arise and pass from the scene, but electricity is ever before us, ever claims attention, and we are sure always will, and, therefore, as this intricate science takes such unprecedented—such gigantic —strides, in giving birth as it does to new facts and new phenomena, I may say daily, it becomes a matter of extreme difficulty for the other than veteran in its service who wishes to be kept fully acquainted with what has been publicly taught in the last couple of years "to keep in the running."

Now, in my opinion, these examination questions cover an enormous part of the whole "magnetic field," and, consequently, to the uninitated of your subscribers explanatory answers to same would be of inestimable service.

Emboldened by your parenthetical remark, or rather query, to "J.G.'s" letter, I venture a little further, and would suggest answers being given weekly to the periodical questions put to students at Victoria University and the Colleges of Glasgow and Bristol.

Thanking "J.G." for his timely suggestion, and you in anticipation for your kind insertion of this seconding note, I am, &c., BURSCHE.

Swansea, October 17, 1882.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should be very glad to see "J. G.'s" suggestion respecting the above in your issue of the 14th inst. carried out, as I think it would, as he writes, benefit many of us junior subscribers.

Hoping you will give it your kind attention, I am, &c.,

16, Grosvenor-park, Camberwell. H. M. N.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have pleasure in endorsing "J. G.'s" suggestion that you answer, if feasible, the questions on electrical engineering given for solution at the last examination in connection with the City and Guilds of London.

I confess I am only a novice in electrical matters, so that, if "J. G.'s" suggestion is carried out, your valuable paper would become still more valuable and interesting to me.—Yours, &c., J. R. H.

20, Kent-road, Ford, Devonport, October 16, 1882.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I, for one, being a student of electricity, would very much like to see the questions in above examination answered, and also in future questions and answers on that science printed in *The Electrician* of any other examination. I have been a reader of this paper for nearly a year, have learnt much, and heartily wish it success. C. S. C.

Norwich.

[Similarly, "W. B." writes from Sheffield, "T. M. C." from Old Broad Street, E.C.; "G. H. L." from Brownswood Park, N.; "J. C. H." from Kilburn, "W. C. J." from Commercial-road, "E. D." from South Kensington, "W. O. B." from Passy, Paris; "E. E. P." from Islington, "W. L. C." from Swansea, &c., &c.]

THE DEVELOPMENT OF THE BELL TELEPHONE.—In an address to the National Telephone Convention, recently held in Boston, U.S.A., Mr. Gardiner G. Hubbard, of the original Bell Telephone Company, and the father-in-law of Professor Graham Bell, the inventor of the telephone, divided the history of the telephone into epochs. "The first was eight years ago, when Professor Bell, rising from a piano where he was seated, declared himself convinced that the sound of the human voice could be carried in tone waves upon electrical wires. Another epoch was later, when one day the professor entered his room and handed him a piece of iron attached to a wire. Placing it to his ear he was amused at hearing articulate sounds. The next was when he stood among others, with the Emperor of Brazil, at the Centennial Exhibition, in Philadelphia. The telephone had been mounted, and was on exhibition. The Emperor, placing the instrument to his ear, started back, exclaiming, "My God, it speaks!" Another epoch was the establishment of the first telephone exchange. Still later and marked periods were when the present management of the American Bell Telephone Company took the control of affairs, and when the Western Union Telegraph Company became identified with its interest."

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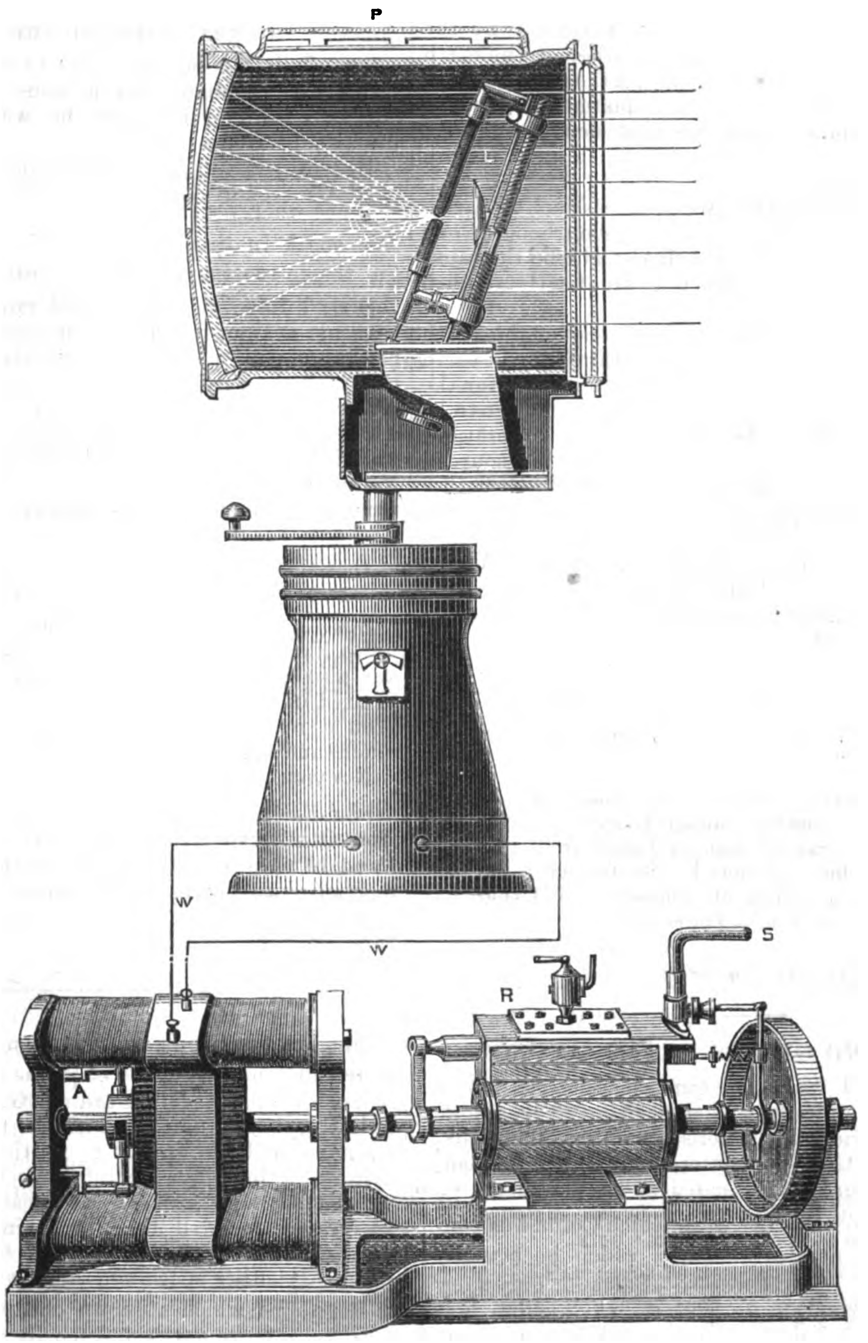
ELECTRIC SEARCH LIGHT.

The British Electric Light Company, Engineers, Heddon Street, London.

We noted in a recent number that the British Electric Light Company had received an order for search lights on account of the Admiralty. We herewith give an illustration of one of these search lights.

The current for the lamp L is obtained from a Gramme dynamo, A, driven direct by one of Hodson's rotary fast-speed engines, R, the steam for which is brought from the boilers by pipe, S. The connecting wires are shown at W. The rays of light from the lamp are made parallel by means of a reflector as shown. The lamp used is a hand lamp without mechanism. The projector P can be turned around on the spindle at the will of the operator.



Electric Search Light for British Navy.

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SOUTH AMERICAN TELEGRAPHS.

The completion of the cable, or rather chain of cables, running along the Pacific coast of the South American continent is an event of unusual importance in the history of submarine enterprise. Not merely is a vast continent encircled, or well nigh encircled, by the all-invading telegraph, but fresh life has been imported into regions which, for centuries past, have been in a state of torpor, varied only by spasms of internecine strife. The work which Columbus contemplated just four centuries ago, and which he actually began on bended knees by the shore of St. Salvador only a few years later is now well nigh completed. Civilisation, not always with bended knee it must be owned, has done its best for that portion of the Western world which has welcomed its good offices. Patagonia still remains obdurate, or perhaps we should rather say unprofitable; for, so soon as commerce discovers anything worth having to be got out of that inhospitable district, the blank space which represents it on the map will begin to fill up, the hostile savage will be improved out of knowledge, and the telegraph will meet at the Straits of Magellan.

The work we are commenting upon, although of exceptional magnitude and interest, has not been one of unusual difficulty. It consisted of a series of cable loops extending along the Southern Pacific coast similar to that of the Atlantic seaboard on the east. Tracing its course from the Gulf of Mexico, we find it touching at Vera Cruz, and onwards through Guatemala and Nicaragua, thence southwards to Panama, where the looping properly begins. The coasts of New Granada and of Ecuador are severally connected with the important cities of Lima and Arica, when the coast of Chili is reached, Valpariaso being its final destination in that direction. From this point a land line traverses the southern continent through Buenos Ayres, making a junction at Monte Video with the coast lines extending northwards by the Brazils. The huge territory comprised in this circuit is probably the richest of the whole world in natural wealth, and it is now girded by an agent which, as a handmaid of trade, bears in her arms riches and honours, and as an instrument of civilisation carries enlightenment and peace wherever she goes.

We speak in this hopeful strain because South America is a theme to inspire the dullest imagination. Nature seems there to have done her best to make the earth bountiful not only in the necessaries of life, but in all its luxuries. Grain in abundance, fruit the rarest, and spices the choicest are everywhere to be had for the growing. Minerals, too, both of the precious and the useful sort, are found in great quantities, and probably exist in many localities which have not yet been explored. Add to this a climate which, though hot, and in some places malarious, is, on the whole, favourable to Europeans, as is proved by the fact that the populations are chiefly of European descent. Yet, thickly dotted as the whole Continent really is with inhabited towns, many of them of considerable size and importance, the sum total of the people who occupy them probably does not exceed some fifty million souls. It has been estimated that there is room for ten times that number to live there in plenty and comfort. A Catholic country, too. What a paradise for the peasants of Connemara and Donegal, if only they would seek it!

Somehow or other, however, the multitude of petty states into which this land of promise is split up have not greatly prospered. From the commencement of the sixteenth century, when Cortez conquered Mexico, and Pazarro founded the City of Lima in the interests of the Spaniards, and when Amerigo Vespucci carried the Portuguese flag to Brazil, there has been a pretty constant succession of wars, insurrections, invasions, and revolutions. With the decline of the splendid nations who were the first to carry European civilisation to the far Western continent, and who brought the native populations into orderly subjection, the hold upon them soon slackened, and they rapidly drifted into a political chaos. Instability of government, and insecurity for property are favourable neither to the spread of industry nor to the cultivation of the arts. With a few conspicuous exceptions, the Central and South American Republics which rose up out of the ruins of imperial Spain have been noted for hardly anything but their commercial inactivities and their national dishonesties. They have served their parents badly, and now, like prodigal children, they are given another chance by friendly hands. It is probably not the last, but it is one of the best that has yet been tried.

This new cable system is costing an American company about a million of money, with a prospect of pecuniary return which most people think is certain, but many consider remote. Be that as it may, the advantages to the trading

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world are immediate and enormous; and these advantages cannot fail to be speedily shared by the countries on whose shores the experiment is being made. Fresh markets will arise for their abounding resources; enterprise will find voice through new channels, and the people inland will in due time betake themselves to the profitable business of conveying commodities to the seaports, and will leave the sanguinary amusement of cutting each others' throats to the Fuegians further south. The completion of this great and useful work is probably inspired by the mammoth telegraph administration of the United States. But we do not grudge the Western Union telegraph the addition which these Pacific cables have made to what some people call its already inordinate dimensions. England has the honour, as usual, of constructing the cables and of laying them down, and England wishes well to any and every enterprise which, like this, tends to civilise the world by linking its members closer together in the bonds of mutual interest and good fellowship.

A GUIDE TO PRACTICE IN THE SUBMARINE CABLE TESTING ROOM.

V.

The test now under consideration being one that is entrusted to young beginners, there are many preliminary arrangements with which, at first, they will have nothing to do, and at the present stage we shall suppose these to have been made, and shall only explain such details of management as they would be permitted and instructed to attempt.

The duty which the learner is called on to attend to is, comprehensively speaking, that of watching the gradual falling of a spot of light down the scale, and he knows that this movement is governed by the conditions of the electrical charge in the quadrants compared with that of each other and of the aluminium needle. Supposing both pairs to be charged to the same potential, no deflection on the scale would follow, but if one pair had a higher charge than the other the balance of effect on the needle would be disturbed, and it would move to one side or the other according to the conditions of its own and the influencing charge. Of course, the connections are so arranged that the spot of light shall move from one end of the scale towards the other end, since the scale only extends on one side of the starting point or zero. Now, owing to various causes, the needle, and, consequently, the mirror does not remain constantly in one position when the instrument is not being used. It is necessary for purposes of accuracy that the spot should be at the zero line at starting, and a means is provided for effecting this object, which we must explain.

The quadrants are so fixed that they can be drawn apart, and it is intelligible that a change of position relative to the needle will cause a change in their effect on its movements. Supposing the quadrants to be free of an electrical charge, the needle, though charged, does not move from its position of rest; but between the intervals of testing there is a tendency to move slightly, owing to a remnant of charge in the quadrants, or one of them, and the spot of light leaves the zero point. There is another cause, but in any case it must be brought back to this point. If it be diverted but very little the scale may be moved to place the zero under the spot, but otherwise one of the quadrants must be slightly shifted. This alters the relative condition of the needle, as just stated, and causes it to move back, bringing the reflection to the proper place. To enable us at any time to do this, a little milled-edge wheel, A (Fig. 8), is fixed on the cover of the electrometer, which by means of a screw acts on one of the quadrants. By gently turning this little wheel, the position of the spot is corrected (see A, Fig. 8).

One more point requires notice, for it is included in the duties which the operator has constantly to look to. The aluminium needle of itself could retain but a feeble and waning charge, and it is, therefore, connected with the acid at the bottom of the glass jar, which latter has strips of tinfoil on its outer side, the arrangement being thus that of a Leyden jar, an apparatus for accumulating or holding an electrical charge (see the text books). When the electrometer is charged the needle is in this way assisted or supplied with electricity, its capacity in this respect being equal to that of the whole arrangement. But even so the charge will decrease, and it is desirable to maintain it as constant as possible. A "replenisher," as it is called, is placed inside the instrument, terminating outside in a little piece of pivoted ebonite, B (Fig. 8), which, when turned rapidly by the finger, sets the former in motion, causing it to act as a source of electricity. It is in effect a tiny electrical machine. In order to observe when the charge is sufficient or not, the student will see at the back of the electrometer cover a small magnifying glass, looking through which he will notice a fine wire stretching across the field of view, and also two little black spots. These form a gauge or standard for guidance. When he finds the wire exactly between the two spots, the instrument is sufficiently charged. If it appears below he must turn the little piece B (Fig. 8) with the finger, making it spin round briskly until the cross-wire is found to have risen to the proper level. Immediately before doing this the terminal C (Fig. 8) must be pressed down; it carries a stiff wire by which one side of the little electrical machine inside is connected to the acid through another wire attached to both. After replenishing, this piece is to be drawn up again. In the figure here given (Fig. 8) we only seek to show as much as actually concerns the learner

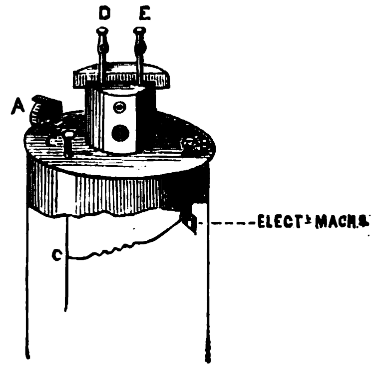

FIG. 8.

for the test. The text books will supply all the details purposely omitted in this place. No part of the instrument should be meddled with beyond what we are telling him he will be required to attend to. The electrometer is so delicate an arrangement that a very little matter disturbs it, and when it gets out of order it is more troublesome to set right than any other instrument in the testing room.

Proceeding now to the more practical part of the subject, the connections may be seen in the plan (Fig. 9). The electromoter faces the scale at a distance of, say, three feet. The piece S Q R T is a short-circuit connection. When the plug is inserted no charge will reach the quadrants, because, in effect, a current would pass to earth by the earth wire from S. The terminals for the two pairs of quadrants are connected to Q and R. That pair, therefore, joined to Q, are always to earth. This is the best way of applying them for the special purpose in view, though another arrangement is used for other tests. The latter pair of quadrants is said to be at the earth or zero potential, and any body, as a cable, whose electrical condition is to be observed being connected to the other pair will communicate its potential to them, and we have thus a means of comparison, taking the earth potential as the standard.

The piece marked M is a "distributor," or arrangement for connecting any one of the terminals 1, 2, 3 to the instrument, and thus bring any one of the cables into communication with the quadrants by means of their leads, which are joined on to each terminal, as seen in the figure. These leads are the *core* leads, or those connecting with one end of the core in the core tanks, this part of the cable being the un-

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sheathed portion continually entering the machine and emerging thence in the form of sheathed cable (see V, Fig. 9). The leads from the finished ends in the cable tanks terminate at C D E, as explained in No. 1 of this series. Here, therefore, they remain constantly insulated whilst observations on the electrometer continue. We may say, then, that one end of the cable is brought to the instrument, and the other end is insulated, speaking generally of the arrangement for the test.

From what was said just now the operator will understand that the passage of the spot of light over the scale shows the rate at which one pair of quadrants differs in potential from the other pair. If the cable were connected with the pair terminating at P, Fig. 9, the spot as it moved down the scale would show the fall of the cable insulation compared with the constant condition of the standard pair of quadrants.

One pole of the battery is put to earth, the other pole being connected to A in the bar A B. The cables being connected to the perpendicular bars C D E, &c., crossed by the battery bar, any cable can be charged by inserting the plugs in the holes where the bars cross each other. The charge then extends through the cable coiled in the cable tank, thence through the sheathing machine to the core in the core tanks, and thence by the core lead to the back of the commutator. The end at the bar on that side is, therefore, insulated when nothing else is joined to the same bar. Of course, this is neccessary for certain tests, for if anything touched the bar and connected it to earth the charge would be dissipated.

minium needle will turn by reason of the difference of potential between the two pairs P and N, since N is to earth through Q S, and the spot of light will pass over the scale to a certain place, and there remain as long as the plug at C (if that be the cable in question) connects the battery to the cable bar. The number of divisions at this time marked by the centre of the spot is called "full potential," and denotes the limit or standard of value to which to compare the amount of fall when a reading from the scale at any lower place is taken. After allowing the charge from the battery to continue for a minute or so, the plugs at A B must be taken out, and here, again, the cable is insulated at *this* end. This end, in fact, is the truly or finally insulated one, because, though both ends would be insulated if the "distributor" were not turned on any terminal, the end at this latter place is constantly being connected with one pair of the electrometer quadrants. The plugs then being out the spot of light will fall back gradually towards zero, supposing the end of the "distributor" handle to be on any one of the cable terminals 1, 2, 3. This handle can be moved round the circle, and as it meets each terminal it presses on it in passing, so as to make a good contact. The operator will now write down on a sheet, properly ruled, the value for full potential, and at certain intervals, say three or five minntes, he will turn the handle on to each cable in succession and record the value for each shown by the spot on the scale. As the minutes pass on the cables gradually lose their charge, and every time the distributor connects one of them to R (Fig. 9), the pair of quadrants communicating with it through N are connected to that cable; and as they then partake of the charge and so

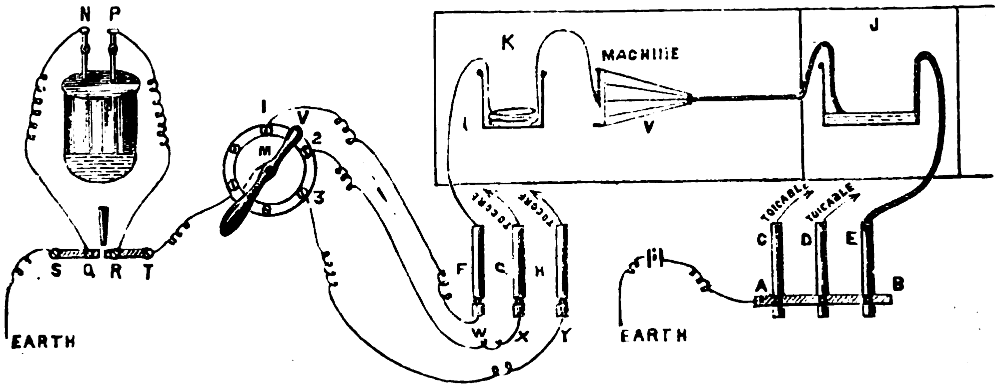

FIG. 9.

Close below the *core* bars is a row of short terminals with plug holes for connecting to the former; from these terminals short leads go to the piece M, and are there joined to the "distributor" terminals.

We will suppose there are three cables to be observed. The leads on either side will be numbered 1, 2, 3; the cable ends on the bars C, D, E; and the core ends on those marked F, G, H (Fig. 9). All preparations for the test being complete, the first thing to be done is to plug in at W, X, Y, thus connecting the cables to the instrument, or rather to the "distributor," where they will be brought into communication with the electrometer when the handle is turned on to them. When these plugs are inserted the cable ends, or more strictly speaking the *core* ends, are insulated at the points marked 1, 2, 3, and care must be taken during the test not to touch them or brush the coat-sleeve against them, otherwise they would be discharged. In the next place the cables must be charged. This is effected by plugging in the three holes through the battery bar A B, but on all occasions of charging the short-circuit plug at Q R must be inserted lest a charge should affect the quadrants when not desired, and because it is not safe to send a charge suddenly through an instrument with a delicate suspension. As soon as the sections are charged, if the handle of the "distributor" M be turned on to any one of its terminals to which a cable is connected (say 3), communication is effected with one pair of quadrants, P, by unplugging at Q R—at the same time the alu-

are at the same potential, they share in the loss—that is say, their loss is the leakage of the cable and, as explained above, the aluminum needle is affected by the change of potential, and tends back to its original position reflected at zero. The duty now consists in repeating the readings at the proper intervals, and thus watching the fall of the spot of light; as long as the fall in each cable is regular, all is right, but if when any one of the cables is connected to the electrometer a rapid fall is seen, or a jumping, jerky movement is observed, the matter must be instantly reported to the electrician in charge. The learner must remember our caution against touching the insulated points. It occurs sometimes that somebody else does this, or, perhaps, some person in the tank houses disconnects a lead. The effect is seen the moment the "distributor" is turned on to the terminal belonging to that section, and, to make sure, the operator must recharge at once, and then see if the spot goes to the proper place. If it does not move the circuit is broken somewhere.

The cables are recharged about every hour, and it is proper to charge them all at the same time if possible, though this cannot always be done, as one cable often falls more quickly than others, and very short sections, or such as have but a small part of their length sheathed always fall faster than long lengths. The repetition of these proceedings at the intervals fixed by the electrician in charge of the room constitutes the work, which the learner can very soon master, and though it is simple and straightforward, yet intelligence and care are essential, as important issues are involved.

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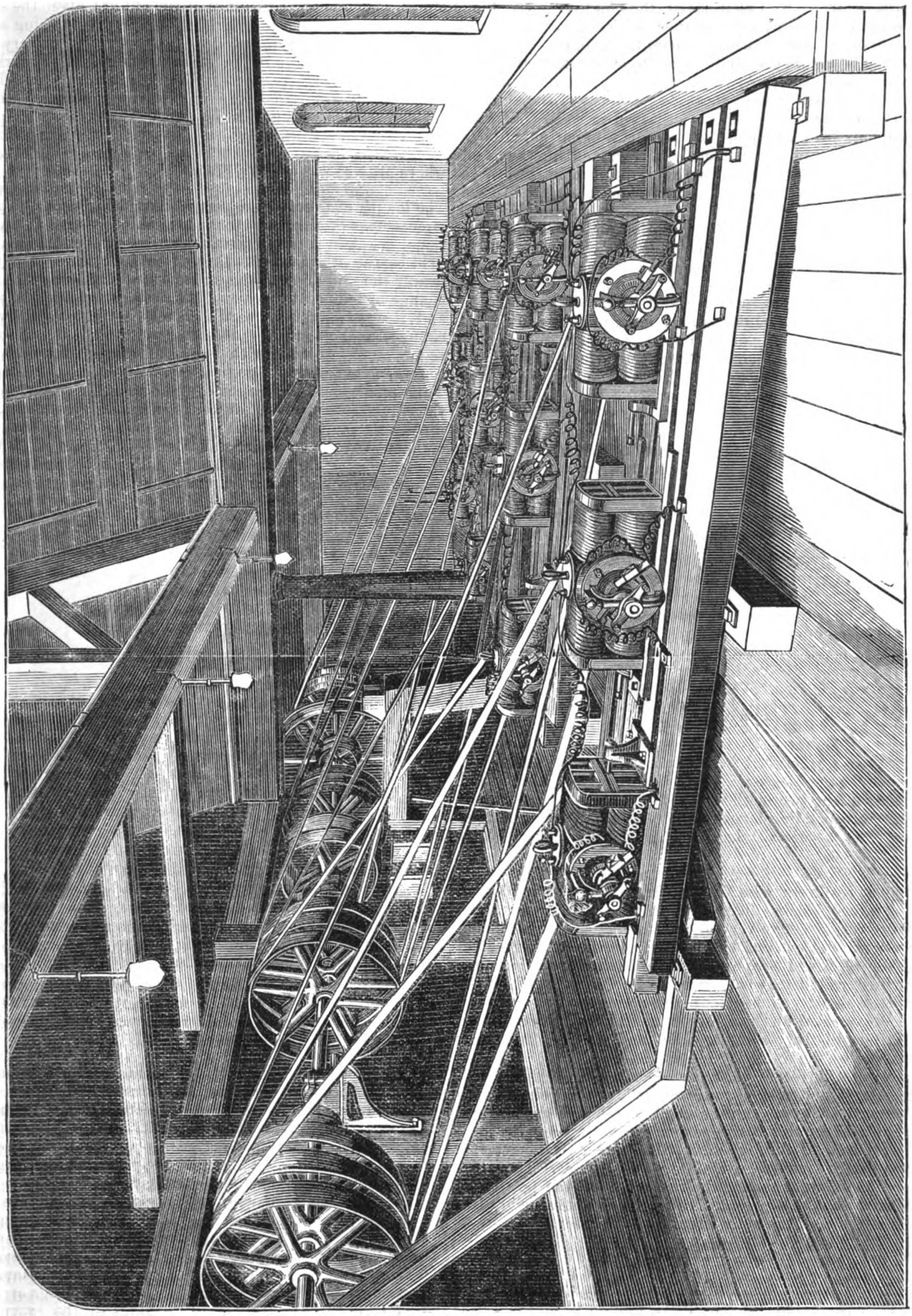
ELECTRIC LIGHT AT BIRMINGHAM TOWN HALL.



The Machine Room.

We are now able to furnish a view of the machine room and the arrangements for driving the Bürgin machines employed to produce the electric light at the Birmingham Musical Festival. We gave a full description of this installation

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and its highly successful working in our number of September 9th, page 395. The view shows the method by which so many machines were driven together in such a manner as to act as one in generating a large current. This is a matter of some delicacy, where a number of machines are to be coupled in multiple arc, as it is essential that they should generate equal electromotive forces.

The three machines in front are coupled in series (but with arrangements for cutting one out, only two being actually in use), and employed only to produce a current in the field magnets of the other machines, also coupled in series, so that those machines which supplied the actual current to the lights being externally excited had all uniform magnetic fields, and, being driven from one shaft at the same velocity, their armatures developed equal electromotive forces.

We hoped to have furnished some further figures, and especially those relating to the horse-power expended; the town authorities have, however, refused to allow Messrs. Winfield and Co. to run the light pending the discussion of their offer to present the fittings to the town on certain conditions. This has prevented the taking of measurements, which were deferred during the pressure of the actual working at the time of the festival.

NOTE ON THE ELECTRICAL RESISTANCE AND THE CO-EFFICIENT OF EXPANSION OF INCANDESCENT PLATINUM.*

BY E. L. NICHOLS, OF RICHMOND, KY.

I.

In the measurement of temperatures above the red heat, platinum pyrometers, in one form or another, are as important as the mercury thermometer is at ordinary temperatures. The researches already completed on the electric resistance and co-efficient of expansion of platinum, and on the specific heat of that metal, only serve, however, as a reminder of the much that remains to be done before we may hope to attain to even a fair degree of accuracy in the measurement of temperatures above 500deg. The present writer, in order to compare the existing formulæ for the temperature of platinum from its electric resistance with those by which the temperature is calculated from the co-efficient of expansion, and thus to gain a clear idea of the relative accuracy and usefulness of the two methods, has determined the resistance and the corresponding length of a platinum wire at various temperatures between 0 deg. and the melting point of that metal.

II.

Upon a platinum wire 0·4mm. in diameter and 100mm. long, at points 55mm. apart, and equally distant from the middle of the wire, two very fine platinum wires were welded. They marked the ends of the portion of wire to be tested, and made electrical connection with a shunt containing a galvanometer. These points were so far from the ends of the wire that when it was heated by the current they were not appreciably cooled by the conduction. The wire was heated by a battery of forty Bunsen cells, and its resistance was determined by the following method :—

The wire A B (see Fig. 1), together with a tangent galvanometer, C, and a resistance box, W, was in circuit with the Bunsen battery. A very small portion of the current was shunted around $a\,b$, the portion of the wire to be measured and carried through a sensitive sine galvanometer, g, and a resistance coil, w, containing 5,000 ohms. Now, if w be very much larger than r, the resistance of the portion of wire $a\,b$, so that the current through $a\,b$ is not sensibly less than that through the main circuit, we shall have

$$r = \frac{\text{tang. V}}{\text{sin. U}} \cdot \text{K};$$

where U is the deflection of the sine galvanometer g, and V the deflection of the tangent galvanometer C, and K a constant quantity.

For, by Ohm's law,

$$\text{E} = c\,r = c'\,r',$$

where c and c' are the currents through $a\,b$ and through the shunt, and r' is the resistance of the shunt; also

$$c' = \sin \text{U}\, k';$$

and when r' is much larger than r

$$c = \text{tan. V}\, k';$$

where k' and k are the constants of the galvanometers.

Then $$r = \frac{\text{tang. V}}{\text{sin. V}}\frac{\text{K}}{\text{K}'}\,r' = \frac{\text{tang. V}}{\text{sin. U}} \cdot \text{K}$$

where $$\text{K} = \frac{\text{K}}{\text{K}'}\,r'.$$

The length of the wire $a\,b$ was measured by bringing the two microscopes of a comparator into such position that the terminal a was in focus in the field of one of them, and b in the field of the other. Since these terminals were each rather nearer the middle than the end of the platinum wire, every change of temperature caused a movement of both a and b, and it was by taking the difference of these that the true change in the length of $a\,b$ was determined. As the microscopes were provided with excellent micrometer scales and screws, a fair degree of accuracy was obtained by this method. Thus readings of the length of the wire at 20deg. agreed with those taken upon a dividing engine to within ·002mm. The distance, $a\,b$, at 20deg. was found to be 53·5576mm. The resistance of the cold wire was found—in terms of U, V, and K—by placing the wire in a naphthaline bath, and obtaining values of U and V with various amounts of current. From these readings a curve was drawn, with $\frac{\text{tang. V}}{\text{sin. U}}$ as abscissæ, and $\text{tang.}^2\,\text{V}$ as ordinates, $\text{tang.}^2\,\text{V}$ being taken as the heat-

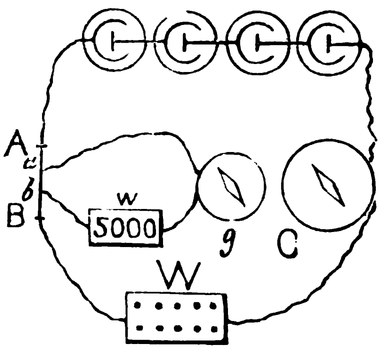

FIG. 1.

ing effect of the current. The point of this curve corresponding to $\text{tang.}^2\,\text{V} = 0$ was taken as the proper value of $\frac{\text{tang. V}}{\text{sin. U}}$ for the cold wire. When measuring the resistance of the hot wire, the galvanometers were read simultaneously before and after each determination of the length. The following table gives the results of the measurements for temperatures ranging between 0 deg. and a point not far below the melting point of platinum. Both resistance and length of wire at 0 deg. are taken equal to unity :—

TABLE I.

Resistance.	Length.	Resistance.	Length.
1·0000	1·00000	3·7090	1·01229
1·0410	1·00002	3·7427	1·01223
1·5071	1·00125	3·7813	1·01285
1·9000	1·00289	3·8750	1·01349
2·1212	1·00380	3·8904	1·01371
2·2934	1·00456	3·9305	1·01378
2·3035	1·00489	4·0303	1·01450
2·7821	1·00732	4·0631	1·01469
2·8633	1·00763	4·0655	1·01495
2·9696	1·00809	4·0747	1·01499
3·3533	1·01022	4·0841	1·01514
3·3741	1·01003	4·1248	1·01540
3·4151	1·01042	4·2005	1·01567
3·6449	1·01160	4·2447	1·01632

*Paper read before the American Association for Advancement of Science.

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III.

Dr. Siemens has published three formulæ for the variation of the resistance of a platinum wire with the temperature. The temperatures were measured in one case (a) from the heating effect of a copper ball, the specific heat of copper being regarded as a constant, while the other two formulæ were derived from direct measurements with the air thermometer. These formulæ are—

$$(a)\ r = {\cdot}039369\mathrm{T}^{\frac{1}{2}} + {\cdot}00216407\mathrm{T} - {\cdot}24127.$$

$$(b)\ r = {\cdot}0021448\mathrm{T}^{\frac{1}{2}} + {\cdot}0024187\ \mathrm{T} + {\cdot}30425.$$

$$(c)\ r = {\cdot}092183\ \mathrm{T}^{\frac{1}{2}} + {\cdot}00007781\mathrm{T} + {\cdot}50196,$$

where T is the absolute temperature, and r the resistance. The following formula by Benoit is also sometimes used for the determination of high temperatures.

$$(d)\ \mathrm{r} = 1 + {\cdot}002445t + {\cdot}000000572t^2.$$

In this formula t is the temperature in degrees centigrade.

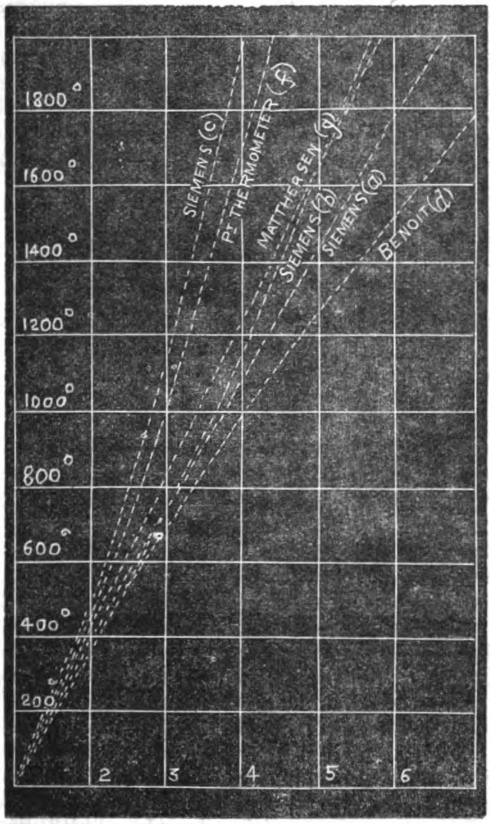

Fig. 2.

When, as is frequently the case, it is more convenient to measure the length of a wire than its resistance, we may adopt Matthiesen's formula, viz.:

$$(e)\ 1 = 1_0\,(1 + {\cdot}00000851\ t + {\cdot}0000000035t^2)$$

[where 1 = length of wire, and t = temperature] ; or use the uncorrected scale of the platinum thermometer

$$(f)\ 1 = 1_0\,(1 + {\cdot}00000886t).$$

These being almost the only data we possess for the calculation of the temperature of a hot wire, the question of their accuracy is of some importance. The formulæ may be best compared by plotting, side by side, the curves which represent them (see Fig. 2). In the figure, resistance is substituted for length in formulæ e and f by making use of the measurements given in the second paragraph of this paper. The following table affords a further comparison of the six formulæ. In the columns a to f are given the temperatures calculated by the various formulæ, at which the resistance of the wire, compared with its resistance at 0 deg. as unity, is given in the column marked r.

Table II.

—	—	Siemens.			Benoit.	Mat-thiesen.	Pt. Ther-mom.
Length	r	a	b	c	d	e	f
		deg.	deg.	deg.	deg.	deg.	deg.
1·0000	1·00	0	0	0	0	0	0
1·0032	2·00	325	402	420	378	342	575
1·0082	3·00	692	812	1108	708	726	917
1·0146	4·00	1086	1244	1950	1000	1170	1623
1·0280	5·00	1464	1682	3170	1272	1638	3100
	6·00	1828	2072		1512	2158	
	7·00	2170	2387		1766	2800	
	8·00	2470	2692		1978		

IV.

The curves marked Siemens b and c were identical so far as the methods employed are concerned, but the platinum used contained some slight impurities. To this the disparity of the results was due. Dr. Siemens found that even such impurities as are usually contained in commercial platinum affected both the resistance of the cold metal and the law of the change of resistance with the temperature.

Benoit's formula (d) depends for its accuracy upon the determination of the boiling points of mercury, sulphur, cadmium, and zinc, for which temperatures he adopted the values given by De Ville and Troost. M. Ed. Becquerel opposed those values at the time of their publication, and later researches have confirmed him, at least, so far as cadmium and zinc are concerned, in thinking them entirely too high. In the following table the results of De Ville and Troost are compared with the more probable values of other physicists :—

Table III.

Metals.	De V. & T.	Other Values.	Author.	Where Published.
Hg.	360	350	Regnault	
S.	440	{ 448	Bennett...	"Am. Jour. Sc.," 1878.
		{ 446	{ Carnelly &	"Journal, Chem. Sc.,"
Cd.	860	772	{ Williams	1876—78.
Zn.	1,040	884	Becquerel	"Comptes Rendus," 1857.

The substitution of these other values in Benoit's formulæ places it more at variance than ever with the work of Siemens and of Matthieson, a variation probably due to the difference of behaviour noticed by Siemens in the case of different specimens of platinum.

This brief discussion of the above-mentioned results suffices, we think, to show that—

1. The formulæ are based for the most part, if even a fair degree of accuracy be claimed, upon unwarrantable assumptions, such as the constancy of the specific heats of copper and platinum, the constancy of the co-efficient of expansion of the latter metal, and upon the accuracy of certain determinations of the boiling points of metals, Zn, Cd, &c.

2. That, apart from the inaccuracy of those data, the variation of different specimens of platinum renders the use of any formula for the calculation of the temperature of the metal from its electric resistance applicable only to the individual wire for which the law of change of resistance had been determined, or, at best, to a wire identical chemically and physically with the former.

3. That, from the data at command, we are not in position to calculate the temperature of an incandescent platinum wire, either from its expansion or change of resistance, further than to find an expression of the temperature in terms of the length or of the resistance of the wire.

4. That, owing to the great variations shown by different

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specimens of platinum as regards resistance, the determination of the expansion is to be preferred, whenever practicable, to the measurement of the conductivity.

THE ELECTRIC LIGHTING ACT, 1882.

(45 AND 46 VICTORIA, C. 56.)

BY WILLIAM GRIFFITH, ESQ., BARRISTER-AT-LAW.

(CONTINUED FROM PAGE 511.)

In our previous article we alluded to the wonderful success which has attended the employment of one of the least understood, yet most useful, of the mighty powers imparted to Nature. From London, as from a centre, the submarine cables stretch under sea and over land till they gain the continents at our antipodes, 13,000 miles away. The capital embarked is large, but, with the exception of two or three companies, it has been well administered. Men who believed in human progress, men who with comprehensive minds reasoning from the ascertained results of past experiments foresaw and provided for the future, have served their generation well, perhaps even better than Sir Rowland Hill, the author of the penny postage. So large is the capital embarked that investment trusts have been formed thereout, the example of which has recently been followed by our railway kings. One of these investment trusts—the Globe Telegraph and Trust Company (Limited)—possesses an issued capital of between three and four millions. It has done much to assist and popularise the other telegraph companies, and we may anticipate, before many years are past, something similar for the electric lighting undertakings. Meanwhile, these undertakings are usually worked by purchasing of some successful patentee one of those brilliant lamps which adorn our railway stations or the streets of the city of London—the Edison, the Swan, the Maxim-Weston, and others. The capital beyond the purchase money need not be large, for licenses may be sold to subsidiary companies formed to work particular districts. The matter, however, has not been forgotten by Parliament. Section 8 of the Electric Lighting Act gives a special power to a local authority authorised to supply electricity to borrow money on the security of certain rates. The security to be offered by the city of London is the Consolidated Sewers Rate; that of the Metropolitan Board of Works is the consolidated rate; that of other parts of the metropolis the rate applicable for lighting; that of the urban sanitary authority the fund, or rate, applicable to the general purposes of the Public Health Act, 1875, in the district, or any other fund or rate applicable to lighting under any local Act; that of the rural sanitary authority the rate or rates out of which special expenses incurred in respect of the contributory place or places comprised within the area of supply are payable under the Public Health Act, 1875.

Similar provisions relate to Scotland and Ireland. The security offered is one of the best. To our own knowledge insurance companies, and other large investors, gladly lend upon parliamentary rates. If the percentage of interest is somewhat small, the permanent income is sure. Parliament has properly placed the borrowing powers under restrictions, and made the consent of certain authorities requisite for its exercise. It has also allowed the local authority of any district to which the Local Loans Act, 1875, extends, to borrow under that Act; and where other Acts apply, to issue corporation or other stock.

The check kept by Parliament on public accounts is now extended greatly. Railway companies are obliged to publish their accounts in certain forms, and so are life insurance companies, and Section 9 enacts that the undertakers shall on or before the 25th day of March in every year fill up an annual statement of the accounts of the undertakers, made up to the 31st day of December then next preceding, in manner prescribed by the Board of Trade.

It has been remarked (Griffith's "Institutes of Equity," p. 127) that "few, if any, chapters of commercial law are more important than that portion of the law of debtor and creditor which relates to securities for loans." It is, therefore, from no forgetfulness of their importance that we have not dwelt upon the borrowing powers of companies—as distinguished from local authorities—formed to light with electricity particular districts; but, because the present Act does not allude to the matter, but leaves the law thereon in its former state, for a consideration of which we must refer to professional legal treatises.

Where the undertakers are private individuals or public companies, the local authority within whose jurisdiction the area which they supply is situate may, within six months after the expiration of a period of twenty-one years (and in some cases shorter periods), and within six months after the expiration of every subsequent period of seven years, purchase the undertaking. We think it savours a little of confiscation that the section provides that to the valuation of lands, buildings, works, materials, and plant, no addition is to be made in respect of compulsory purchase, or of goodwill, or of any profits which may or might have been made from the undertaking, or of any similar considerations—Section 27. Gas undertakings have frequently been sold, with parliamentary sanction, at twenty-four years' total of the profits.

Special protection is afforded to the constructors of docks and basins near canals, and the undertakers, on request, are to remove and place their lighting apparatus accordingly—Section 10. The Postmaster-General and his telegraphs are protected by very elaborate sections, referring some disputes to arbitration, and imposing heavy fines for wilful non-compliance of the undertakers—Sections 26 and 35. Nothing in the Act is to "limit or interfere with the rights of any owner, lessee, or occupier of any mines or minerals lying under or adjacent to any road above or across which any electric line shall be laid to work such mines and minerals." Section 33. To our friends in the city and others acquainted with the value of lead and tin mines, iron and coal mines, and brick clay, this precautionary measure may be thought to be of value. Notwithstanding the extremest care, the breaking up of streets, the altering the position of pipes and wires, and the other works must be expected to produce some damage. Accordingly, Section 17 enacts that, in the exercise of the power in relation to the execution of works given them under that Act, or any license, order, or special Act, the undertakers shall cause as little detriment and inconvenience, and do as little damage as may be, and shall make full compensation to all bodies and persons interested for all damage sustained by them by reason, or in consequence of the exercise of such powers, the amount and application of such compensation, in case of difference, to be determined by arbitration.

Section 28 provides generally that, where any matter is by this Act, or any license, order, or special Act directed to be determined by arbitration, the Board of Trade may appoint an engineer or other fit person to act as arbitrator; and classes licenses and provisional orders with special Acts within the meaning of the Board of Trade Arbitration Act, 1874.

Every well painted picture has its contrasts of light and shade; and it is a cause for regret that the greater the success of the electric lighting undertakers, the greater will be the loss of the gas undertakers. Let us hope that the latter body of gentlemen will be wise in time, and in many cases be the first to supersede gas by themselves supplying electricity. Their probable loss has been anticipated by the Right Hon. J. Chamberlain, and provided for. Section 29 enacts that, where a supply of electricity is authorised within any area in which a supply of gas also is authorised, the Board of Trade may, upon the application of the gas undertakers inquire into the circumstance of the case, and in their discretion relieve the gas undertakers from their obligation to supply.

Section 23 enacts that "any person who maliciously or fraudulently abstracts, causes to be wasted or diverted, consumes or uses any electricity shall be guilty of simple larceny and punishable accordingly." This is not happily worded. The framer thereof doubtless meant to promote honesty, but in carrying out his meaning sufficient attention has not been paid to that scientific accuracy which in the criminal law is all important. Simple larceny is defined to be the wrongful

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taking and carrying away the personal property of another with a felonious intent to convert it to the taker's own use without the consent of the owner. (Broom's "Commentaries," 948.) It is the same as what in the Ten Commandments is called stealing, in Scotland theft. Section 36. But it appears to be a totally different act from waste, however wrongful and tortuous that waste may be. Bearing in mind the observations of Cockburn, C. J., upon the codification of the criminal law and the difficulty of reducing to measure those general principles which constitute and distinguish guilt and innocence, we are of opinion that in many cases the judges would direct the juries to acquit where the undertaker would feel sure of catching a negligent customer, for negligence may be malicious, and yet not fraudulent, it may show personal spite or a general disregard of the rights of others, both which the law defines to be malice and yet not be thieving in the accurate sense of the term. At the same time the section is sufficiently sweeping to be regarded as an unscientific and dangerous, though well meaning innovation. We think that on principle and authority fraudulently abstracting electricity would be larceny, independently of the statute. For if there be a guilty mind, or an intention to steal, the first act of removing the property constitutes the larceny. Thus, on an indictment for stealing porter it appeared that the prisoner had made a hole in the barrel through which the porter flowed into a can on the ground; but a person snatched up the can while the porter was running into it in the presence of the prisoner. It was held that there was a sufficient removal or asportavit by the prisoner to complete the felony. ("R. v. Wallis," 3 Cox C. C. 67.) So where the prisoner had contracted with a company for the supply of his houses with gas to be paid for by meter and without the knowledge of the company inserted a connecting pipe between the meter's entrance and exit pipes the jury were told that the prisoner had no lawful interest in any gas until it had passed through the meter, and that the stop-cock on the connecting pipe being opened by the prisoner, and a portion of gas being propelled through it by atmospheric pressure, and consumed at the burners, there was a sufficient severance to constitute the asportavit, which, joined with the fraudulent intent, made the prisoner guilty of larceny. (" R. v. White," 2 " Russell on Crimes," 127).

Some seven years ago the inhabitants of the metropolis were thrown into a state of alarm by rumours of a strike by the *employés* of the gas companies. So serious was the evil considered, that the legislature passed an Act making it penal for an *employé* wilfully and maliciously to break a contract of service, knowing, or having reasonable cause to believe, that the probable consequence of his so doing would be to deprive the inhabitants wholly, or to a great extent, of their supply of gas. (38 and 39 Vict., c. 861-4). This Act for amending the law relating to conspiracy, and to the protection of property, has not been specifically extended to persons employed in electric lighting. The Electric Lighting Act concludes with two sections which make the new law, with the few following modifications, applicable to Scotland and Ireland:—In regard of Scotland (*a*), the expression "Lands Clauses Acts" means the Lands Clauses Consolidation (Scotland) Acts, 1845 and 1860; (*b*) "simple larceny" means theft; (*c*) "felony" means a high crime and offence; (*d*) "public purposes" means lighting any street or any place belonging to, or subject to the control of any public authority, or any church or place of public worship, or any hall or building belonging to, or subject to the control of any public authority, or any public theatre, but shall not include any other purpose to which electricity may be applied; (*e*) "local authority" means, as regards streets and roads, the authority having the control of the streets and roads. In regard to Ireland, (*a*) where the consent of the grand jury of any county to the breaking up of any road is required under the Act, such consent may be signified by the county surveyor, and where it is required under this Act that notice should be given by the Board of Trade to the grand jury of any county, and an opportunity afforded to such grand jury to state objections, such notice may be given to, and such objections may be stated by, the county surveyor on behalf the grand jury; (*b*) " Public Health Act, 1875," means the Public Health (Ireland) Act, 1878.

LITERATURE.

Electro-motors. **A Treatise on the Means and Apparatus Employed in the Transmission of Electrical Energy and its Conversion into Motive Power, for the use of Engineers and others. By J. W. Urquhart. [W. T. Emmott, Manchester.]**

Within the past two years and a half this author has had published four, if not five, books on electrical subjects. Four of these books at any rate we have before us, viz., "Electro-plating," published by Crosby, Lockwood, and Co.; also by the same publishers, "Electric Light" and "Electro-typing;" the fourth is the one with the title at the head of this notice. Till now we have allowed Mr. Urquhart's works to remain unnoticed, inasmuch as we had hopes that he would discontinue to write. There are paragraphs, nay pages, in these works which bear internal evidence that if the author would write one-hundredth less in amount, and give one hundred times more thought to what he did write, his work would be useful. As it is, his work is after the fashion of "linked sweetness long drawn out." Repetition of commonplaces, padding from periodical literature, facts without deduction, added to such sentences as "The cost of a medium-sized machine is £60. It absorbs about 2½ horse-power. The French agents are A. W. Kipling and Co., 55, Boulevard Saint Martin, Paris," make up some of these works. We do not object to mentioning the horse-power absorbed, nor the price, but think the name and address of the French agents given in the middle of the pages of a scientific treatise is going a little beyond the ordinary rules regulating the making of books. A price list and a directory combined is a useful enough book, but one hardly asks for this in a work entitled "Electro-typing." There has, indeed, been a rush upon books containing information on electrical matters during the past two or three years, yet we cannot commend the practice of knocking together a book in such harum-scarum fashion in order to catch a market.

The first book, that on electro-plating, is certainly the best of Mr. Urquhart's productions, that on electric light, edited by F. C. Webb, having had the great advantage of being overhauled by a man whose knowledge and experience makes him specially competent for such work. It is difficult to compare the work on electric light with the others, or to credit Mr. Urquhart on its production, inasmuch as there is no indication of how far its good features are due to the editor rather than the reputed author.

We fail to find in this new work on electric-motors any signs of a thorough comprehension of the problems introduced into civilised life by the advent of electricity as a transmitter of power. It consists of descriptions such as any schoolboy could have cut out from the pages of periodicals, strung together, and called a book. The things which everybody knows are found here; those that few know, or have considered, and which engineers especially desire to know, are absent. Some one must declaim against mere book-making. We are sorry to do it, more especially as these works show, as we have said, in parts that the author could have performed yeoman's service in the propagation of electric information had he given himself due time for really good work.

Practical Information for Telephonists. **By T. D. Lockwood. [W. J. Johnston, New York.]**

The publisher of this little work is himself one of the most energetic of the propagandists of electrical literature. The editor and proprietor of *The Operator* has made for himself a unique position, and has by indomitable perseverance and business tact succeeded where so many others have failed. He has published some of the "liveliest," and, to coin an American expression, some of the side-splittingest articles and books pertaining to the subject of electricity. His colleagues seem imbued with his spirit, and write with a freedom of interspersing anecdote with grave matter that

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is not altogether consonant with our ideas of scientific writing. Mr. Lockwood has given us a very readable book. He sketches the history of electricity from 600 B.C. to 1882 A.D. What author could avoid doing this, even if his treatise were on the right way to fashion the spring to an armature? Only ten short pages are occupied with this history, then we come to the consideration of the telephone proper. The instrument and its accessories are considered from every point of view. The internal and external work of a telephone office is described, and good advice is given to the various grades of *employés*, in a manner which must render it very effective, and yet so as to raise no shadow of offence. Towards the end of the book the author deals with the cognate subject of electric bell construction, and then concludes with short chapters on "Housetop Lines, Pole Lines, and Ærial Cables," and "Anticipations of Great Discoveries and Inventions." This last chapter is very interesting, showing as it does that most of the discoveries and inventions lay for years unnoticed, and were made popular by re-discoveries, or by men better known in scientific circles. Thus Duverney and Galvani, Sulzer and Volta, Christie and Wheatstone, Cavendish and Ohm, Romagnese and Oersted, Pacinotti and Gramme, Varley and Minotti, &c., are names connected in the manner described. We have previously said that Mr. Lockwood's book is very readable, and we should think many telephonists and telegraphists on this side would welcome it not only for its information and its interest, but for its fun.

Détermination des Eléments de Construction des Electro-Aimants. By M. TH. DU MONCEL, Membre de l'Institut. Deuxième edition. [Gauthier-Villars, 55, Quai des Augustins, Paris.]

This work, devoted to the consideration of the construction of electro-magnets, is too little known to English readers. Although perhaps no publisher could be induced to incur the expense, we think the work should be translated and published in an English dress, for the benefit of students whose acquaintance with any other than their mother tongue is meagre. The right construction of dynamo-machines, of arc-lamps, and of other electrical apparatus, depends upon the knowledge of the principles underlying the action of electro-magnets. We may safely say that there are but few English manufacturers and but few students who could write a specification for the construction of, say, a straight electro-magnet that, with a given current, should attract a given weight at a given distance with a given force. We cannot now enter into a discussion of the whole question, and remain content to indicate the value of the work in a general way. It discusses the matter in ten sections, each section dealing with one branch of the subject, such as (I.) "Formules des Electro-aimants," (II.) "Conditions de Maximum des Electro-aimants sur un Circuit Simple," and so on. The fifth section is especially useful for students, giving (V.) "Exemples numériques de l'application des formules précédents." It is customary with some English critics to speak of French authors as not appreciating or not knowing the work which has been done in England, but the French may safely retaliate that we in England have little conception of the immense amount of work that has been done by Comte Du Moncel, their most prolific author on electrical subjects.

The Modern Applications of Electricity. By E. HOSPITALIER. Translated by J. MAIER, Ph.D. Illustrated. [Kegan Paul, Trench, and Co.]

We have had several books treating on electrical subjects upon our table for some time, but have been hitherto unable to take that notice of them which they deserve. The author of the work now mentioned is one of the most energetic of the younger French authors; the French edition of his work has been noticed by us, so that it will be needless to dwell at length upon the translation of Dr. Maier. The book is intended to be popular; it describes the apparatus devised during the progress of the last few years without entering deeply into principles. It is well illustrated, and altogether is a work from which the intelligent reader may glean a large amount of descriptive information. Whilst, however, bestowing our praise on the descriptive matter, we must state that the more scientific statements are made in a most slip-shod manner. In some cases this is evidently due to the lack of knowledge of the translator, and forms another link in the chain of evidence that the translator of a technical work should have some acquaintance with the technicalities of the subject. The following is an example of what we mean :—

"Let us suppose, for instance, the pressure between A and B to be 100 volts; by introducing an incandescent electric lamp between these two points, the intensity of the passing current will be

$$C = \frac{100}{100} = 1 \text{ ampere.''}$$

The translator evidently looks upon every incandescent lamp as having the same resistance, viz. 100 ohms. This is far from being the case. The sentence should specify the resistance of the lamp to be 100 ohms, as the next sentence specifies the resistance of the arc lamp to be 4 ohms. Other minor faults might easily be pointed out, such as the use of galvano-plastic, and other terms not common to English eyes and ears. We talk of electro-plating, of electrolysis, &c. Still, while mentioning these few blemishes, we admit that generally the translation is correct, and for the ordinary public the work is one of the best published.

ELECTRIC AND GAS ILLUMINATION.*

BY C. M. LUNGREN.

(CONCLUDED FROM PAGE 526.)

There remains to be considered the cost of the coal in the case of gas, and the expense of running the engines in the case of electricity. The cost of coal per 1,000ft. of gas made was, in the case of the London companies, $36\frac{56}{100}$ cents, corresponding to 3·51dols. per ton, the make of gas being for this amount of coal 9,529ft. This was offset by the sale of residuals, as below:

Coke and breeze	11·16	cents.
Tar and products	7·18	,,
Ammonia and products	5·72	,,
Total	24·06	,,

—which leaves 12·8 cents as the net cost of the coal.

Compared with foreign companies, both in England and on the Continent, but very little is done with the residual products in this country, and the amounts received vary greatly between different works. Reliable data on this point cannot be obtained, but under the most favourable conditions this item cannot be taken as amounting to more than one half the cost of coal, while with most works it is probably inconsiderable. The average price of the coal used may be placed at 4·50dols. a ton, and the amount of gas produced 10,000 feet, making the cost 45 cents per 1,000 feet. This make of gas can hardly be maintained with a production of residuals equal to one half the cost of the coal; but, assuming that it is, the cost of the coal becomes $22\frac{1}{2}$ cents per 1,000 feet.

In the foregoing estimate of the electric plant it has been assumed that eight lamps could be maintained throughout the entire distributive system for each actual horse-power expended upon the pulley of the dynamo machine. That this is entirely feasible has been proved by careful tests made by experts in no way interested in any of the lamps, and their results can therefore be accepted without question. For such a use as electric lighting the cost of a horse-power may safely be taken as not above the best results hitherto obtained in practice. In general manufacturing, the item of power, while important, is not sufficiently so to demand that constant and great care necessary to obtain the very best results, and hence few engines and boilers yield in practice the same results as in special tests. With electric light companies this item, on the contrary, is vital, and we may confidently expect to see them in time obtaining their power at a considerably less cost than is now common. Mr. Edison finds as a matter of fact confirmed by several months' test at Menlo Park, that he is able to maintain a horse-power an hour with five pounds of slack (one-third pea and two-thirds dust), costing 2·45dols. a ton. For the purpose of the present

* From the *Popular Science Monthly*.

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comparison, however, it is best to make a liberal allowance, and take for a 200 horse-power engine a consumption of four pounds of coal an hour, the coal costing 4·50dols. per ton of 2,240 pounds, delivered. A horse-power will then cost $\frac{8}{10}$ of a cent. an hour, and we may rightly abate our liberality sufficiently to include in this cost the cost of the oil for lubricating the engine and dynamo.

The maintenance for an hour of 200 electric burners, the equivalent of the 1,000 feet of gas, will therefore cost 20 cents, as as against 22½ cents for the gas.

Summing up the results so far obtained, the two accounts stand as follow:—

PLANT ACCOUNT.	Per 1,000 feet Gas.		Electricity.	
Interest	12·		12·	
Depreciation of producing works	10·		6·	
Depreciation of mains	2·5		1·1	
	——	24·5	——	19·1
Manufacturing expenses :—				
Labour	12·		9·	
Coal	22·5		20·	
	——	34·5	——	29·
Working expenses :—				
Distribution		2·5		2·5
Total		61·5		50·6

Under this last heading there should be added rent and taxes, management, law charges, bad debts, and various incidentals. These cannot be separately arrived at with any closeness, but they may be taken in the lump as about the same part of the total charges as in the case of the London companies, which is 16 per cent., exclusive of the interest on investment. This in the present case would be 9·4 cents per 1,000, bringing the total cost per 1,000 up to 71 cents with gas and 60 cents with electricity.

The promoters of the electric light would probably demur to this statement, so far as rent and taxes are concerned, as they insist upon the much smaller real estate required with the electric than with a gas plant. This difference does not, however, seem to me sufficient to be of any practical moment, as the real estate in the case of electricity is in the district supplied, where the price of land is relatively high, while the gas companies can readily place their works in such locality as to compensate in lowered land value for the greater amount required. Gas companies can, moreover, build within much smaller limits than usual when for any reason it is desirable, and closely approach the space requisite for an electric installation.

An item of considerable amount which has been omitted from the estimate from electricity is the cost of the renewal of the lamps. With the general introduction of incandescent electric lighting, this is a charge which would fall directly upon the consumer, but it is one which would steadily diminish with improvement in lamps. Assuming, however, that it is a legitimate charge upon the company supplying the light, the item amounts to 10 cents per 1,000, if the lamps have a life of 600* hours and cost 30 cents. This brings the electric account up to 70 cents per 1,000.

So far as coal gas is concerned, then, these figures show a slight advantage in favour of electricity, and while they are only approximative, they are near enough to the truth, I think, to represent the actual relation of the two illuminants. While very much, doubtless, remains to be done in the improvement of coal-gas manufacture, it does not seem probable that this will affect its cost of production to the same extent as future improvements of electric apparatus may be expected to decrease that of the electric light. Looking closely at the two accounts, it does not seem probable that the item relative to plant will be materially lessened in the future. The cost of the plant has already been taken at a figure very near the lower limit, so near that the substitution of this in its place would make a difference in the yearly plant account of but 2½ cents per 1,000. We may, on the other hand, expect improvements to largely reduce the cost of the electric plant. On Mr. Edison's system of distribution the size of the conductors varies inversely as the resistance of the lamps, so that they may be materially if the resistance of these latter can be increased; while any improvements affecting the number of lamps per horse-power diminishes both the interest account by reducing the plant and the actual cost of production.

How far coal-gas can go in a reduction of the cost of production it is difficult to say, but I think the lower limit may safely be taken at the point at which the sale of residuals pays for the coal. Both of these items—cost of coal and prices of residuals —are practically beyond the control of a gas company. The coal is already purchased in the open market at the lowest figures at which it can be obtained, and the market for residuals depends chiefly upon the development of chemical industries, which can hardly be hastened by the action of a gas company. This market is a steadily growing one, and it is not impossible that the residuals will in time pay for the coal, though it is hardly probable. The items of labour and distribution cannot probably undergo any considerable reduction. The limit, then, below it which does not appear that there is any probability of coal gas falling in this country is 46 cents per 1,000, which is a figure that may be reached by electricity without assuming anything less probable than the above supposition respecting gas. It is only necessary to get ten lamps per horse-power, and produce the latter with three pounds of coal an hour, to bring the cost down to 47 cents, exclusive of the lamps.

As a present competitor, however, what is known as water gas —gas produced by the decomposition of steam in the presence of coal or oil—appears to be more formidable. This mode of gas manufacture has the advantage of coal gas in a lessened cost of the producing plant, a smaller labour account, and a decreased appreciation of the generating apparatus. Its successful competition with coal gas ultimately depends upon what the latter can make of its residuals, as there is no offset of this kind in its case, but with present conditions it can go below it. The producing portion of the plant costs but little more than half that for coal-gas, while the labour is about a third, and depreciation but slightly more than this. A sixteen-candle gas will require three gallons of oil per 1,000 feet, and can be made with oil at 5 cents a gallon and coal at 4dols. 50 cents a ton, at an expenditure of 28 cents per 1,000 feet for materials. The total cost will not exceed 60 cents.

Such, then, appears to be the relation of these two agents on the basis of illumination solely, but it must not be forgotten that the amount of light which each plant can furnish does not represent the actual relative capacity of the two. The electric plant can be run not only four hours a day for light, but any further number of hours for power, without any increase of the machines. The gas-plant, on the other hand, would have to be increased, to furnish both power and light. That this advantage of electricity is liable to be a very important one will hardly be questioned when the extent of the field open to electro-motors is borne in mind.

On these figures the cost of electricity is near enough to that of gas to enable it to offer a very substantial competition, and one which may be expected to grow stronger with increased experience and future improvements. That under the stimulus of this competition considerable improvement will be made in lighting by gas seems very probable. Already it has been shown that in the matter of burners there is a wide field for invention, and that the results now usually obtained are much under what are possible. With the high-power burners of Siemens, the illumination obtained from sixteen-candle gas has been more than doubled, and in others it has been carried up to from five to five and a half candles per foot. How suitable burners yielding such a great increase of light will be for the general purposes of lighting, and whether they can with advantage displace the simple flat tip, remains to be seen, but the present indications are that it is chiefly through the use of improved burners that gas must endeavour to resist the assaults of the incandescent light. Competition on the basis of a gas of higher illuminating power simply, without a resort to improved burners does not seem very promising. The recently published report of the sub-commission appointed to test the incandescent lamps at the Paris Exhibition, of which Mr. Crookes was a member, shows that a thirty-two candle lamp can be maintained with an increase of from 28 to 37 per cent. of the power required to sustain one of sixteen candles, while with gas such an increase of illumination will require an additional expense of fully 50 per cent. of the cost of one of the lower candle-power. This is so with the Lowe gas, with which three gallons of oil are sufficient to give sixteen candles, but six are required for thirty-two, and it is not probable that coal-gas can be enriched any cheaper. Whether the limit to progress in gas lighting, both in the matter of improvement of manufacture and burners, is sufficiently far off to give gas unquestioned possession of the field of lighting or not the result can alone determine. But, if the figures presented in this paper can be at all relied upon, they show that gas manufacturers and those interested in gas property will do well not to underrate the strength in their own domain of this rising industrial power.

* I am informed by Mr. Edison that the average life of the lamps is now 900 hours, including three per cent. breakage in handling.

A New Lamp.—A new lamp, devised by a Mr. E. A. Sperry, was exhibited at the Globe Hotel in Syracuse, U.S.A., September 21. According to a Syracuse paper, Mr. Sperry claims that his lamp has fewer parts than others and a larger percentage of the current is utilised for producing the light than in other lamps, and an improved governor for maintaining uniform light is employed.—*Sanitary Engineer*.

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WEST COAST OF AMERICA TELEGRAPH COMPANY.

The directors have to present to the shareholders the annexed accounts for the year ending 31st December, 1881, showing the gross revenue to be £32,356 15s. 11d., against the sum of £17,398 14s. 2d. for the previous year, and leaving a net balance of profit of £1,308 13s. 6d.—a result which may be looked upon as satisfactory, regard being had to the continuance of the deplorable war between Chili and Peru, and considering that the Company's terminal station at Lima was only open for traffic for half of the year, whilst Mollendo, another of the Company's stations, was blockaded by the Chilian fleet during the whole of the year. Notwithstanding, however, the continuance of active hostilities, and the utter stagnation of trade at Lima and at other places on the west coast, the board are glad to report that the income of the Company continues to increase, and that the next balance-sheet of the Company, which will be issued at an earlier date, will show a considerable improvement in its position and prospects. The interest upon the debentures of the Company has all been paid, and the amounts included in the balance-sheet in the item £8,299 15s. 8d. "Outstandings due by Company" have been paid also. The expenditure of the repairing steamer "Retriever" shows a sensible decrease, whilst her earnings show a material increase of £2,286 6s. 10d. For the current year she has been employed in assisting to lay the new cables on the Pacific coast, and has earned up to this time £6,900, an amount considerably in excess of her earnings for the corresponding period of last year. The net increase in the income of the Company for the present current year amounts, so far as it has already been ascertained, to a sum of about £7,000.

The board regret that, despite their anxious and unceasing efforts, they cannot as yet announce a settlement of the Company's claim upon the Chilian Government. It is not advisable at the moment to enter into details, but it may be stated that, yielding to the influences brought to bear by the board, the Chilian Government not only assented to the appointment of arbitrators in the matter, but it has in a sense anticipated their decision by offering a sum of money in settlement of part of the claim, leaving the other part to be prosecuted hereafter. This offer the board have declined, and instructions have been sent out to the coast for the claim to be urged and pressed forward in every way compatible with the interests of the Company, and with the present difficult position of the Chilian Government. Regarding the prospects of the Company, the board are pleased to announce to the shareholders that the new cables of the Central and South American Telegraph Company, extending for some 3,000 miles along the Pacific coast, have been opened for public traffic this week. These cables, completing the circle of the South American Continent, give this Company a new route, and establish direct communication from Valparaiso to the whole of the Central American Republics, to the United States, and to England. Agreements have been completed by the board with the Central and South American Telegraph Company and with the Mexican Telegraph Company for the transmission and exchange of the traffic which this Company will obtain through the opening of these new and extensive lines. With a cessation of hostilities, and anything like a revival of trade upon the coast, these lines should bring a marked accession to the business of the Company.

The board regret to report the untimely death of Mr. Rose-Innes immediately after his return from the West Coast, where for some months he had rendered valuable service in looking after and promoting the interests of the Company. The members of the board retiring by rotation are Mr. Matthew Gray and Mr. Robinson Kendal, both of whom, being eligible, offer themselves for re-election. The vacancy caused by the death of Mr. Rose-Innes the board do not propose to fill up at the moment.

The auditor, Mr. J. Weise, of Turquand, Youngs, and Co., retires, and offers himself for re-election.

THE ELECTRIC NEWS-TELEGRAPH COMPANY (LIMITED).

The first general meeting of this Company was held on the 13th inst. at the Cannon-street Hotel, in compliance with the requirements of the Companies Act, 1867. General Sir Michael Kennedy, R.E., K.C.S.I., presided.

The SECRETARY (Mr. John Cooper) having read the notice convening the meeting,

The CHAIRMAN, after reminding them that that was the first general meeting of the Company, stated that it was incorporated on the 5th of June, and that the total number of shares issued had been 7,805, representing a nominal capital of £39,025. The amounts due on application and allotment and on the first call had all been received, with the exception of a small sum, which was now in process of adjustment. The terms of payment to the vendors had been altered from those stated in the prospectus by a reduction in the cash payments from £23,500 to £6,000 and £3,000 in debentures, and by a corresponding increase of payment in fully paid-up shares. When the prospectus was issued there were eighty-two subscribers, paying a total annual sum of, say, £3,270, while there were now 118 subscribers, paying an annual sum of, say, £4,660. Their outgoings were at the rate of, say, £5,000 per annum, so that there was nearly an equilibrium between outlay and receipts; and as preliminary and many general charges were already provided for, the greater part of fresh subscriptions would go to profit. He, therefore, thought they would agree with him that, as regarded their home business, their prospects were very encouraging. They were now in negotiation for the sale of their patent rights out of England. These negotiations, though they were in a very advanced stage, had not yet been finally concluded, but he hoped and thought they very soon would be, and that they would shortly be in possession of results very favourable for the Company. For obvious reasons it would not be wise in him to enter into any detail on the subject, and he was sure they would see this; but he begged them to believe that the directors had the shareholders' interests at heart, and would, with the assistance of their energetic and able managing director (Mr. Burnside), do all in their power to secure the interests of the Company. He should be happy to answer any questions to the best of his ability.

Mr. HUNT expressed a hope that there was no fear of litigation with the rival company.

The CHAIRMAN, in reply, said he did not think so. They had had no indication of it at present, and he thought if there had been any intention on their part to oppose this Company in any way further they would have done so by now.

On the motion of Mr. HUNT, seconded by Mr. KER, a vote of thanks was passed to the chairman.

The CHAIRMAN, in acknowledging the compliment, repeated that the directors had the shareholders' interests entirely at heart.

The meeting then separated.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The half-yearly report of the directors of this company shows a revenue of £88,842, and a working expenditure of £23,156, inclusive of £10,609 spent on cable repairs. After bringing forward the undivided profits to December 31, there is a balance of £103,295, of which £19,500 has been required for the interim dividend paid in June, while £50,000 has been added to the reserve fund, which, with interest on investment, now amounts to £407,663. The directors recommend a final distribution of 3s. per share and a bonus of 2s. per share, both free of tax, making an aggregate distribution for the year of 7 per cent., and leaving £1,295 to be carried forward.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The accounts of this company for the half year ended June 30 show a revenue of £46,994, an outlay of £36,667, and a balance of £10,327, which with a small sum brought forward is raised to £12,621. Of this £5,000 is added to the reserve fund, raising it to £46,844, and £7,621 carried forward.

GLOBE TELEGRAPH AND TRUST COMPANY.—This company announces the payment of an interim dividend for the quarter ending the 18th inst. of 3s. on the preference shares, and 2s. on the ordinary shares.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES OCT. 18.		BUSINESS DONE WEEK ENDING OCT. 18. Highest.	Lowest.
Anglo-American	50,	51	51¼	50¾
Do. Preferred	82,	83	83¼	82½
Do. Deferred	20,	21	21	20¼
Brazil Submarine	12¼,	12⅜	12 5-16	12½
Cuba	9¾,	10¼	9⅞	9 13-16
Do. Preference	16,	17	17	16½
Direct Spanish	6,	6½	6⅛	6½
Do. Preference	15,	16	15⅞	15¾
Direct United States Cable	11¾,	12¼	12⅛	12 3-16
Eastern Telegraph	10⅝,	10⅞	10 13-16	10⅝
Do. 6 per Cent. Preference	12¾,	13	12 15-16	12 15-16
Do. 5 per Cent. Debentures, 1899	101,	104	—	—
Eastern Extension	11⅝,	11⅞	11⅞	11⅞
German Union	9¾,	10¼	—	—
Globe Telegraph and Trust Company.	6½,	6¾	6¾	6½
Do. Preference	12½,	12¾	12¾	12⅝
Great Northern	12¼,	12¾	—	—
Indo-European	31,	32	31⅝	31½
Mediterranean Extension	1¾,	2¼	2	1⅞
Do. Preference	8,	9	—	—
Reuter's	12½,	13	—	—
Submarine	250,	260	254	254
West India and Panama	1⅜,	1⅝	1½	1 9-16
Do. 1st Preference	7,	7½	7⅜	7¼
Western Brazilian	6¾,	7¼	7	6⅞
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1,	1¼	1¼	1⅛
Oriental	¾,	1	⅞	⅞
United Telephone	10¾,	11¼	11⅛	11

ELECTRIC LIGHT.

Anglo-American Brush	12¾,	13¼	14¼	12½
Maxim-Weston	½,	¾	¾	11-16
Eastern Electric	3,	3¼	3	2¾

TRAFFIC RECEIPTS FOR SEPTEMBER, 1882.

COMPANIES.	Sept., 1882.	Sept., 1881.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,250	2,030	220	—
Direct Spanish Telegraph Company	1,812	1,790	22	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	32,955	30,866	2,089	—
Eastern Telegraph Company	57,271	47,407	9,86	—
Great Northern Telegraph Company	21,280	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

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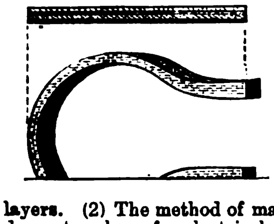
RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

261,264. Carbon for Electric Lamps, *Henry A. Seymour, Washington, D.C., assignor to George W. Stockly, Cleveland, Ohio.—Filed January* 10, 1882.

Brief.—The weak portions of one of the layers are re-enforced by the strong portions of the adjacent layers. *Claim.*—(1) An electric lamp incandescent carbon composed of paper or paper-like substance, having two sets of long fibres arranged in layers, and the long fibres of one portion of the layers being at an angle to those of

261.264



the other layers. (2) The method of manufacturing incandescent carbons for electric lamps, substantially as described, the same consisting in cutting layers or elementary filaments in different positions from paper having its long fibres parallel with each other, and combining a number of these layers having the fibres in different positions to form a complete blank or filament, and then carbonising the whole.

5322. Improvements in Electric Accumulators, *J. Imray, London.—6th December,* 1881.—(*A communication from J. Carpentier and Dr. O. de Pezzer, Paris.*)—(*Not proceeded with.*) 2*d.*

The inventors proposed to make their negative plates very thin, and their positive ones about twice the thickness and half the surface area of the negative plates. Other modifications in the form of the plates are also proposed.

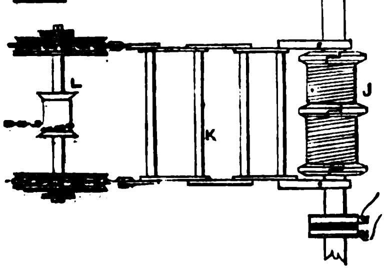
5738. Electric Lamps, *G. J. G. Lorrain, Westminster.—31st December,* 1881. 4d.

This invention consists in silvering or coating a portion of the globe with a reflecting material.

5751. Improvements in and Relating to Apparatus for Operating or Controlling Railway Brakes by Electricity, *W. R. Lake, London.—31st December,* 1881. —(*A communication from A. L. Duwelius, L. W. Goss, Paget Higgs, F. R. Merrell, H. D. Peck, and H. Walker, America.*) 6*d.*

This consists in the provision of a rotary engine, dynamo and storage battery on the locomotive, with a switch, so that the battery may be charged, or the current applied to the brake mechanism at will. The locomotive and the carriages are all connected by suitable conducting wires, with branches leading to the brakes. The

5751



construction of part of the brake is shown in the figure, J being a rotating electro-magnet provided with flanges and centred upon one of the rotating axles of the vehicle. A chain armature, K, is wound upon the peripheries of the flanges. This armature terminates in chains wound upon a windlass to which the ordinary brake chain is attached. Normally the armature chain is out of contact with the peripheries of the flanges of the magnet, but when a current passes the armature chain is attracted and adheres, the rotation of the magnet drawing the succeeding bars of the armature upon its flanges.

71. An Improved System of Automatic Electric Printing Registers and Return Signals, &c., *A. J. Boult, of Thompson and Boult, High Holborn, London—6th January,* 1882.—(*A communication from B. F. Valentine, New York*). 10*d.*

This invention relates to a system of telegraphing signals for different purposes, such as to call the police, give alarm of fire, &c., and has for its object improvements on present systems, whereby a legible and lasting record of the signal shall be printed by the receiving apparatus, and whereby the nature of the call and the source from which it came shall be indicated at a single impression of the printing mechanism.

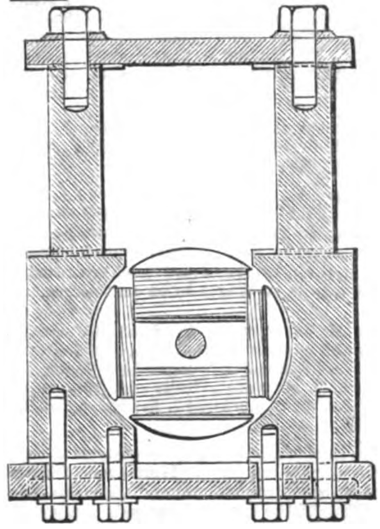
5126. A New Hermetical Voltaic Pile, *R. H. Brandon, Paris.—23rd November,* 1881.—(*A communication from C. A. Mystrom, Paris.*) —(*Not proceeded with.*) 4*d.*

This is an improvement on the original pile of Volta, and consists in the wet conductor being surrounded by an impermeable elastic substance which adapts itself hermetically to the metallic discs between which the said conductor is placed.

5681. Improvements in the Construction and Arrangement of Dynamo-electric Machines, *J. Richardson, of the firm of Robey and Co., Lincoln.—27th December,* 1881. 4*d.*

This consists in the arrangement of a series of two armatures at right angles to each other, as shown in the accompanying figure, and so fitted in connection with the field magnets that one is

5681



at the point of maximum when the other is at the point of minimum intensity, and as one increases in intensity in the same ratio that the other diminishes, the sum of the two will produce a constant intensity of current.

5286. Improvements Relating to the Production of the Electric Light in Electric Lamps, in the Means for and Methods of Manufacture of the Carbons, &c., *A. R. Sennett, Worthing, Sussex. —3rd December,* 1881. 6*d.*

This relates to incandescent lamps. The inventor constructs his carbons of material containing a high percentage of cellulose, such as linen cuttings, &c. These are mechanically reduced, and then deposited in layers in a special depositing apparatus connected with an air pump, so that layers of the material of uniform thickness are obtained. It is then inserted in dies and subjected to hydraulic pressure. The air is exhausted from the die before pressure is applied, and the pressure is increased very slowly. The material is then carbonised in a chamber from which the air is exhausted previous to the heat being applied; a stream of vapour of bisulphide of carbon is also caused to pass through this chamber. The carbon is then fixed on to the conductors, there being no material difference in sectional area between the carbon clamps and conductors at the point of junction. The other parts of this invention refer to the supporting of the carbon and attaching the conductor wires, and to exhausting the globe.

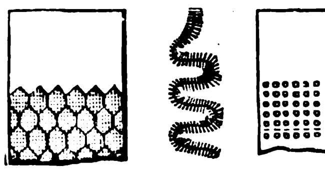
72. Secondary or Reversible Electric Batteries, *R. Kennedy.—6th January,* 1882. 2*d.*

The electrodes are lead, upon which spongy lead is deposited.

260,654. Secondary Battery, *C. F. Brush, Cleveland, Ohio.—Filed June* 15, 1882.

Claim.—The method of forming the plates of a secondary battery consisting in forming recep-

260.654



tacles for oxide of lead in its surface, then applying oxide of lead to the plate and within such receptacles, and afterwards subjecting the oxide of lead to pressure.

5304. Operating the Keys of Organs, Pianos, &c., *H. J. Haddan, Kensington.—5th December,* 1881.—(*A communication from J. Bommelaer, Dunkerque.*)—(*Not proceeded with.*) 2*d.*

This relates to the application of electro-magnets to mechanical organs, &c., and which act on levers which depress the required keys as a current passes through the magnets, and release them when the current is interrupted.

5316. An Improved Arrangement and Combination of Apparatus for Lighting Railway and other Carriages by Electricity, *R. Laybourne, Newport, Mon.—5th December,* 1881. 6*d.*

This consists in a combination of dynamo machines and secondary batteries placed in some part of the train, the dynamos being driven by gearing from the axle of a carriage. The secondary batteries supply current to electric lamps in the train when the train is at a standstill.

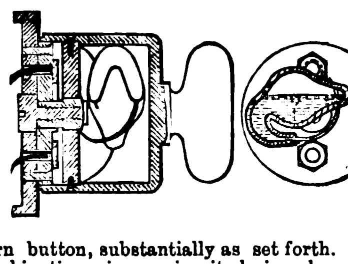
5104. Improvements in Electric Batteries, *A. M. Clark, London.—22nd November,* 1881. —(*A communication from G. Fournier, Paris.*) 4*d.*

The inventor takes lead oxide in powder and mixes it with glycerine so as to form a thick paste fluid enough to run into moulds. After twenty-four hours in the moulds it sets in a mass which is insoluble in water. It is very reducible when immersed in dilute sulphuric acid, and in circuit with metallic zinc it becomes reduced to the metallic state as fast as the zinc is attacked. Thus is obtained metallic lead in a complete state of division, which will be readily deoxidised for use again as a depolarising agent, or become peroxidised, and can therefore be used in secondary batteries.

260,864. Circuit-closing Key for Electri Lamps, *John H. Guest, Brooklyn, N.Y.—Filed April* 24, 1882.

Claim.—(1) The combination, with a glass vessel containing mercury, of two electric conductors passing into such vessel, a turn button supporting such vessel and conductors, stationary contact surfaces, and contact surfaces upon the

260.864



turn button, substantially as set forth. (2) The combination, in a circuit-closing key, of an insulating vessel containing mercury, and into which vessel the metallic circuit wires pass, and separate cells in the vessel, containing mercury around the ends of such wires, and means for moving the vessel and bringing the mercury therein into contact with the mercury in the cells for closing the circuit, substantially as set forth.

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5354. Improvements in Apparatus for Indicating the Speed of Revolution of Shafts, *Lieut. P. Cardew, R.E., Chatham. 7th December*, 1881. 6*d*.

The invention consists of a magneto-electric machine and a galvanometer. The current generated by the machine is proportional to the velocity of rotation, the galvanometer or indicator measuring the current so generated. The galvanometer employed is similar to an ordinary "needle telegraph" instrument, with steel needle maintained at zero by a bent magnet which clasps the galvanometer coils, so that its poles are near those of the needle. The dial is graduated with a suitable scale on either side of the zero point, and this scale is so figured that the number of revolutions of the engine per minute can be read off at once. Resistance coils are also provided in the circuit to adjust the total resistance, until it is found that the instrument indicates truly. Other indicators in the shape of thermometers are also described.

5360. An Improvement or Improvements in or Connected with Telephone Transmitters, *E. H. Johnson, New York.—7th December*, 1881.—(*Not proceeded with.*) 2*d*.

The inventor uses a transmitter, consisting of an electrode of metal of high specific resistance, such as tellurium, boron, &c., in combination with a diaphragm, an induction coil, and a battery.

5367. Machine for Coating Insulated Electrical Conductors with Lead, *W. R. Lake, London.—8th December*, 1881.—(*A communication from H. S. Maxim, Brooklyn, U.S.*).—(*Not proceeded with*). 6*d*.

Molten lead is pumped into an annular chamber and from thence flows out with the wires to be covered.

5335. Improvements in Telephones, and in Lightning Arresters Therefor, &c.—*G. W. Foster, Strand, London.—9th December*, 1881.—6*d*.

One form of the inventor's telephone consists of a case furnished with an exterior groove for receiving a coil; a hole for a magnet, and two holes bored at an angle for the telephone wires. The permanent magnet has a screw cut head, which fits into a fixed metal screw-cut adjustment collar, whereby the magnet can be adjusted with reference to the diaphragm. The invention also consists of a combined lightning and binding post device, consisting of two metal pieces arranged in a ring shape, provided with threaded connections for holding the contact points of the telephone wires, and suitably connected with the ends of the telephone helix, said pieces being fashioned with teethed surfaces, and placed in close proximity.

5521. Improvements in Electric Lamps, *R. Kennedy, Glasgow.—17th December*, 1881. 8*d*.

This relates both to incandescent and arc lamps. With regard to incandescent lamps, the invention consists of improvements in a mercury pump for exhausting the glass globe. The inventor constructs his carbons of the fibres of the aloe plant, and the joint of the platinum wires with the carbon is made durable by the deposition of carbon on it. In the inventor's arc lamp the upper carbon is attached to the core of a solenoid in the lamp current. The lower carbon is held by a cross-bar held up by cords passing over pulleys to counterweights proportioned to give the lower carbon an upward feed. On the pulleys are fixed ratchet wheels, and in connection with these wheels are catches which are movable by the holder of the upper carbon. When the current through the solenoid is too weak, the upper carbon descends, and at the same time releases the pulleys, so that the lower carbon rises.

5542. An Improved Galvanic Battery, *W. R. Lake, London.—17th December*, 1881.—(*A communication from La Société Universelle d'Electricité Tommasi, Paris.*) 6*d*.

This consists in improvements on the Daniell cell as follow:—The zinc and copper are in form of wires from five to seven millimetres in diameter, twisted spirally, or arranged in parallel lines joined by curves. One end of each of these wires protrudes for use as a terminal. The porous cell is replaced by a sheet of parchment or dialised paper arranged horizontally, and the edges of which are plaited or folded, and rise above the level of the liquid. The arrangement of the cell is, first, sulphate of copper crystals, then copper wire, then parchment paper, in the interior of which is arranged a circular piece of cord, on which is placed the zinc coil. The vessel is then filled with dilute sulphuric acid.

5521. Improvements in Secondary or Polarisation Batteries, &c., *G. Grout and W. H. Jones, Hornsey, Middlesex.—17th December*, 1881. 4*d*.

The inventors take flour or other vegetable or carbonaceous substances reduced to a powder, and intimately mix it with the oxide or a salt of lead or other metal, and add a sufficient quantity of water, syrup, or other liquid to make it into a plastic mass fit for moulding; the moulded material may then be dried or not before being placed in a closed vessel surrounded with powdered carbon or other substance capable of preventing direct contact with the atmosphere. It is then exposed to a gentle red heat for a sufficient time to carbonise the organic matter with which the oxide is combined, and reduce the oxide to the metallic state within the pores of the carbon. Rods of lead may be inserted before carbonising for affixing the terminals to. A second portion of the invention consists in taking a combination of lead in sheet or other form, and heaping or piling round it lead mechanically reduced to a dusty or granular state.

5573. Improvements in and Relating to Telephones and Telegraphs, *W. R. Lake, London.—20th December*, 1881.—(*A communication from J. H. Rogers, Washington, U.S.*) 8*d*.

The object of this invention is to enable messages to be sent secretly, and consists in the employment of two or more circuits, so that any one tapping one circuit would only obtain confused and unintelligible signals. The inventor causes the message to pass through the two circuits alternately in rapid succession. The current conveying the signals is thrown first into one and then into the other circuit in regular alteration, by means of a circuit-breaker; so that any one tapping the one circuit would only obtain confused signals. The inventor also describes apparatus for the transmission and reception of signals on this plan.

5577. Electric Telegraphs, *Sir J. Anderson and B. Smith, London.—20th December*, 1881. 6*d*.

The usual way is to have a complete set of instruments for each cable, in which case a message by one cable is received by one instrument and then sent on by another instrument. This apparatus is intended to avoid such retransmission, and to enable messages to be sent direct.

5595. Improvements in Electric Calls for Telephones and Analogous Purposes, *A. W. Lake, Addison-gardens North, London.—21st December*, 1881.—(*A communication from W. C. Lockwood, Brooklyn, New York.*) 6*d*.

The inventor employs the power of a weight or spring to ring the gong. The power of the weight is kept ready for use immediately the electrical condition of the line is disturbed. The mechanism for operating the call insures that the weight shall be kept constantly wound up. The call is effected by what may be termed "overwinding" the weight. The same signal is produced at both ends of the line by the overwinding at either end. The apparatus is so arranged in connection with an electro-magnet and connections that the winding of the apparatus by changing the circuit from one condition to another makes the call, and the running down of the apparatus by changing the circuit again to its previous condition discontinues the call.

5601. Improvements in Elecrical Brushes and Combs, *J. N. Aronson, London.—21st December*, 1881. 6*d*.

This relates to the combination with a brush or comb of an induction coil and battery.

5618. A New or Improved Holder for Incandescent Electric Lamps, *D. Graham, Glasgow.—22nd December*, 1881. 6*d*.

This relates to a holder for incandescent lamps. It consists of a block of insulating material, in one end of which a screw thread is cut for attaching the holder to gas brackets, &c. On this block is placed a spring socket for holding the tube of the glass globe, this socket being made in two parts, insulated from one another. Into each of these parts a pinching screw passes, which, when the lamp is in the socket, bears upon two metal tongues joined to the platinum wires of the carbon. These screws form connections between the conducting wires and the lamp. The holder may be provided with a switch for making and breaking contact.

5604. Improvements in Galvanic Batteries for Electric Lighting, &c., *E. B. Burr, Walthamstow, and W. T. Scott, Stratford, both in Essex.—22nd December*, 1881. 6*d*.

This invention relates to improvements in batteries, whereby they are rendered convenient, efficient, and portable. The battery consists of zinc and carbon plates arranged in wooden cells lined with waterproof cement. The space in the cells surrounding the plates is filled with asbestos fibre or like material, and this is saturated with a mixture of bichromate of potash, phosphoric acid, and sometimes a small quantity of nitric acid.

5615. Improvements in the Construction of Cables or Collections of Metallic Conductors for Telephonic and Telegraphic Communication, *J. N. Culbertson, M.D., Antwerp, and J. W. Brown, Upper Kennington-lane, London.—22nd December*, 1881. 6*d*.

This relates to improvements on patent No. 1,679, 1881, taken out by the same inventors. Pipes of convenient lengths are employed with perforated insulating discs at each end. The wires are threaded through these discs and strained tight. The pipes are joined together and the joints closed. For above-ground work, the inventors employ troughs open on the under side, so as to form a roof to protect the wires.

5627. Improvements in Electric Call Signals, *H. J. Haddan, Kensington, Middlesex.—23rd December*, 1881.—(*A communication from G. W. Foster and F. B. Wilson, Paris.*)—(*Not proceeded with.*) 2*d*.

This consists of clockwork provided with an escapement in combination with a double helix furnished with a metallic rod having an armature on one end which is placed directly in front of the helix. The movement of the armature consequent on a break in the current releases the escapement and causes a hammer connected with the clockwork to strike a gong.

5639. Improvements in Electrical Alarm Apparatus for Railway Trains, &c., *D. S. Garau, Hatton Garden, London.—23rd December*, 1881. 6*d*.

This consists in providing each carriage with two insulated conducting wires, each carriage being connected to its neighbour by a suitable coupling. A battery and alarm bell is provided in the guard's van, and an alarm bell on the engine. In the carriages are a suitable number of contact makers, so that, when contact is made, the bells in the van and on the engine will ring, or should the coupling of a carriage break the same thing will occur. The inventor also provides a signal arm or other indicator in each carriage which will project when contact is made and an alarm given, so as to indicate the particular carriage.

5656. Improvements in Apparatus for Working Electric Clocks and Certain Combinations of Electric Clock Apparatus on One and the Same Line, &c., *E. G. Brewer, Chancery-lane, London.—24th December*, 1881.—(*A communication from C. E. Buell, New Haven, U.S.A.*) 8*d*.

The object of the first part of this invention is to dispense with the use of local batteries at substations on a line used for controlling electric clocks, and to substitute a combination of a relay in a constantly closed main circuit with a secondary battery in a derived circuit, together with a clock to be operated by the battery in such circuit, the whole being combined with an electro-magnetic switch controlled by the relay in the main circuit, so that in one position of the switch the secondary battery is charged by the current in the main line, whilst in the other position the derived current from the main line is broken, and the current of the secondary battery is closed locally through the controlling electro-magnet of the clock. The second part refers to the transmission of fire alarm signals on the same circuit as the clock; and the third to the transmission of telephonic signals on the same circuit.

5661. Improvements in Pipes or Conduits for Containing Electrical Conductors or Wires, *J. H. Johnson Lincoln's Inn-fields, Middlesex.—24th December*, 1881.—(*A communication from C. Labye and L. de Locht-Labye, Paris.*)—(*Not proceeded with.*) 4*d*.

This relates to an improved method of arranging and enclosing conductors in a conduit or chamber constructed with a removable cover.

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SLIP

Cable Repaired.—The cable between Fao and Bushire is repaired.

Telegraphic Extension in Queensland.—The telegraph line has been extended to Herberton in this colony.

New South Wales.—Rumours are again afloat in this colony of proposed reductions in intercolonial telegraph tariffs.

Electric Light in Mexico.—It is stated that the electric light has been introduced on the Mexican Railway at Orizaba.

Brazilian Submarine Telegraph Company.—The traffic receipts of this company for the week ended October 20th amounted to £3,984.

Newcastle-on-Tyne Telegraph Office.—The number of telegrams passing through this telegraph office during last year was about two millions.

West Indies.—Telegraphic communication is now restored with all places in the West Indies, the several cables recently reported broken having been repaired.

Meeting.—The eighteenth ordinary general meeting of the Eastern Extension Telegraph Company is to be held at the Cannon-street Hotel on the 1st November at 2 p.m.

Telegraph Lines Interrupted.—During the latter part of last week and the beginning of the present one considerable interruption was occasioned on the Teheran and Turkish telegraph routes owing to inclement weather.

The Society of Telegraph Engineers and of Electricians.—At the first meeting of this Society for the autumn session, which begins in November, Mr. W. H. Preece, F.R.S., will read a paper on "The Munich Electrical Exhibition."

New Cable to Tripoli.—A telegram dated Malta, October 25, says:—"The telegraph ship 'Kangaroo' has arrived here to-day after successfully laying the Tripoli cable." This cable has been laid by the Eastern Telegraph Company.

Electric Power for Shoemaking.—In the Cincinnati (U.S.A.) Industrial Exhibition, a model shoe factory may be seen. The Goodyear sewing machines, used for making ladies' shoes, which are shown in the factory, are driven by means of electricity.

Western and Brazilian Telegraph Company.—The traffic receipts of this company for the week ending October 20th, 1882, were £2,603, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

Electric Lighting.—The Town Councils of Manchester, Bolton, Glasgow, Hull, and the Gas Commissioners of Dundee, have all resolved to apply to the Board of Trade for provisional orders enabling them to supply electricity to their respective districts.

Electric Lights on Ships.—The Edison Company are about to fit up the new steamboat "Pilgrim," of the Fall River line, with 770 of their lamps. One L and two K machines, run by a special engine of about 85 horse-power, will supply the necessary current.

Electric Lights for Troopships.—The Admiralty have decided to light the troop ship "Himalaya" throughout with the electric light. The lamps to be used are the Swan incandescent. The dynamo machines are of the Siemens type, driven by Brotherhood engines.

Electric Light in Private Houses.—A drawing room in the neighbourhood of Ware (Herts) was lighted up on 19th inst. by two Swan lamps, the current being supplied by a battery of 16 Bunsen cells. The lamps were alight from 7:30 p.m. to 3 a.m., and burned steadily and well.

Electrical Teaching in Germany.—The celebrated Polytechnic School at Darmstadt, which is largely frequented by English students, has just been considerably enlarged. Among the additions is that of a Chair of Electro-Technology, which will be filled by Dr. Kittler, late of Munich.

Spread of Electrical Education.—There are now attending Professor Ayrton's electrical laboratory at the City and Guilds of London Technical College, Finsbury, some 300 students, amongst whom are the *employés* of every important electric light and electrical engineering firm in or near London.

Fires Caused by Electric Light Wires.—Within a short time there have been two fires in the passenger station of the Boston and Albany Railroad Company, caused by electricity employed in lighting electric lamps. Both the fires, says an American contemporary, were caused by insufficient insulation of the wires.

The Post Office Volunteers.—We are glad to be able to chronicle the safe return of the detachment of 24th Middlesex, or Post Office Volunteers, from Egypt, where they have fulfilled their duties very satisfactorily. They have been under fire, we believe, some of them, more than once, but return without any casualties.

New Atlantic Cable.—A *Times* telegram dated Philadelphia, of the 22nd inst., says:—"The proprietors of four influential American newspapers have subscribed the stock in the new Baltimore and Ohio Cable Company. The papers are the *New York Herald*, the *New York Times*, the *Baltimore Sun*, and the *Cincinnati Enquirer*."

Ireland.—Consequent on the death of Mr. Sanger, late divisional engineer of the postal telegraph service in Ireland, which we reported in our last issue, that country has been now divided into three engineering districts, viz., northern, midland, and southern, of which Messrs. J. Walby, W. Louth, and H. Pomeroy, respectively take charge.

The Swan Light in Holborn.—We understand that Messrs. Laing, White, and Wharton have been appointed agents to the Swan Electric Light Company, and that the installation of Swan lamps in their premises at Holborn, mentioned by us in a recent note, is for the purpose of allowing any one desirous of doing so to see the light in operation.

Telegraph Wire Wanted.—The Cheshire Lines Committee are inviting tenders for the supply of telegraph wire and materials. Patterns can be seen, and specification, &c., obtained on application to Mr. W. H. Legge, storekeeper, Cheshire Lines, Warrington. Tenders are to be sent to Mr. Edward Ross, secretary, London-road Station, Manchester, by 12 noon on 14th November.

Electric Light at Eastbourne.—The extinction of the electric lights on the Parade, at Eastbourne, on Thursday week, was entirely due, we learn, to the failure of the water supply. As electric lighting stations are very dependent on the water companies, would it not be as well for them to erect small reservoirs? They would then be able to tide over any irregularities in the supply of water.

Long Distance Telegraphy.—The *Operator* says that some few weeks back the Western Union lines were continuously connected from Boston, Mass., to Chihuahua, Mexico, a distance of 3,037 miles. Subsequently this feat

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was excelled by a connection from San Francisco, California, *viâ* New York to Tor Bay, Nova Scotia, a distance of 4,125 miles, about 600 miles of this being by ocean cable.

THE ELECTRIC LIGHTING ACT, 1882.—The following alterations have been made in the rules issued by the Board of Trade in August last, in pursuance of Section 5 of the above Act: Rule V. The words "The lands which the applicants propose to take for the purposes of the license or order" have been omitted. Rule IX. The wording of the first few lines of this rule have been altered in order to make the meaning more clear.

RUSSIA AND THE TELEPHONE.—We do not hear much of any progress being made with the telephone in the Russian Empire. A facetious contemporary explains this circumstance by the fact, if it is a fact, that the exclamatory halloo! with which, as everybody knows, all telephonic conversation must begin, is, in the Russian language, rendered Tzijakanfitkrajanjanzski! which, of course, no telephone yet invented can pronounce.

FAURE ELECTRIC ACCUMULATOR COMPANY.—An extraordinary general meeting of this company is to be held at the Cannon-street Hotel on the 6th November at 1:30 p.m., to consider whether the company shall purchase foreign patents for accumulators, especially those of Faure, Sellon, and Volckmar, with the object of forming companies abroad to work these patents. The meeting will also consider questions as to the voting at meetings.

LONGMAN'S MAGAZINE.—The first number of this magazine, that for November, 1882, has just been issued. It contains, amongst other things, an article by Professor Tyndall on "Atoms, Molecules, and Ether Waves." This shows that the editor of the new magazine is determined to afford his readers a sprinkling of scientific amongst the lighter food for thought which we find throughout its pages. We wish this addition to the periodical literature of the day all success.

NEW COMPANIES.—The following companies have filed articles at Albany, N.Y.:—The Commercial Telegram Company, capital 50,000dols.; the lines of the company are to run from New York to different cities in this and other States. The Mexican Northern Telegraph and Telephone Company, of New York, capital 200,000 dols.; its line is to run from New York through the State of New Jersey, and thence in a south-westerly direction to the city of Laredo and other cities in Mexico.

BANKRUPTCY OF A TELEGRAPH ENGINEER.—In the Edinburgh Bankruptcy Court on Monday last, Alexander M'Lean, telegraph engineer, of West Register-street, Edinburgh, appeared for examination. The liabilities were stated to be £1,725 7s., and the assets about £18 15s., after deducting £46 6s. for preferable claims. It will be remembered that Mr. M'Lean was the defendant in the recent telephone case tried in Edinburgh, the United Telephone Company being the plaintiffs. Judgment was given against the defendant.

FOLLOWING SUIT.—At the last meeting of the Works Committee of the Clerkenwell Vestry a member moved "That this committee recommend the Vestry to oppose the application of all electric lighting companies for licenses under the third section of the Electric Lighting Act, unless they are prepared to guarantee to this Vestry, after paying a dividend of 7½ per cent., that one-half of all profits should be given to the Vestry towards the reduction of the local rates, in consideration of the concession granted for laying down their necessary works." The resolution was not adopted, as the question was postponed to a future meeting. It is evident, however, that the example set by the Vestry of St. George's (Southwark) will be followed by others.

MR. ST. GEORGE'S TELEPHONE.—The chief novelty about Mr. St. George's method of transmitting and receiving telephonic signals is in the receiving instrument, though some special advantages are also claimed for the microphonic sender. The receiver, which is exceedingly light and compact, consists of a small electro-magnet, in front of which, and affixed to a disc of prepared wood, is a coil of fine wire tightly wound and twisted upon a tiny reel. The varying currents in the electro-magnet induce corresponding strain in the neighbouring coil, which is taken up by the wooden tympanum and communicated to the ear. Its articulation is loud and clear.

THE EDISON SYSTEM IN AMSTERDAM.—A large flour mill in Amsterdam known as "De Weichsel" has been lighted by means of 58 A and 20 B Edison lamps. The current is supplied by an Edison Z dynamo. Although the steam engine which drives the dynamo and a great deal of the machinery in the mill runs at 58 to 62 revolutions per minute, we are informed that the candle-power of the lamps is nearly constant. At 10 o'clock 10 A and 10 B lamps are cut out of circuit. The remaining lamps burn the whole night without overheating the armature of the dynamo, which proves to be very good. The director of the flour mill (Mr. Reynvoon) is well satisfied with the working of the system, and the light is found to be an improvement on the gas lighting. The work has been carried out under the charge of Mr. H. C. Van Alens, electrician to the Dutch Edison Company.

ELECTRIC LIGHTING IN PHILADELPHIA.—According to the regulations issued by the City Council of Philadelphia (U.S.A.), it appears that no streets can be broken up for the laying of underground wires until permission has been obtained from the council. That no street shall be opened for a greater distance than 500ft. at one time, and that the trench is not to exceed 2ft. in width. Persons breaking up the streets are to be liable for damage to gas and water mains, sewers, and sewer connections. No electric light circuit is allowed to use the ground as a part of the circuit, but all circuits must be metallic, otherwise have a return wire. Cut-offs must be provided where the wires pass into a building, and the city of Philadelphia may use any wire for municipal purposes free of charge. For every mile of conductors for electric lighting 15dols. per year must be paid to the city, and 5dols. per year for every mile of conductors for telephonic and telegraph purposes.

THE GALE.—On Tuesday last a terrific gale passed over the British Islands, causing great havoc amongst the telegraph lines. The Submarine Telegraph Company gave notice that great delay would be caused in the transmission of messages to the Continent, and Wednesday morning's papers were without a great deal of their usual continental news owing to the breakdown. On Tuesday, shortly before one o'clock, passengers in Cannon-street were alarmed by the sudden breaking away of one of the telegraph wires over the post-office immediately opposite the City Terminus Hotel The wire curled through the air with terrific force, and an omnibus had a narrow escape of being caught by it. Two gentlemen who were crossing the road also narrowly escaped. Almost simultaneously with the occurrence another wire just above the entrance to Walbrook snapped, but fortunately no one was hurt. A staff of men from the Post Office was promptly on the spot and the wires repaired.

ELECTRIC LIGHTING AND GAS IN AMERICA.—Tenders having been invited for lighting the streets of Jersey City

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for one year from 1st December next, the following were received:—For electric lighting, W. Baxter offered to supply 100 arc lights of 1,000 candle-power each, for 18dols. per lamp per month, or 21,600dols. for the whole for one year. The Jersey City Gasworks Company offered to light 900 lamps for 22·39dols. each per year, or 1,000 for 22dols each (at present the city is paying 24dols. per lamp). The remaining bids were all for oil lamps, ranging from 1·19dol. to 1·40dol. per lamp per month. There were two bidders at the lower figure, viz.: Alfred Speck and Stephen Parrish, both of Jersey City. The *Sanitary Engineer* (New York) says that it is intended to give the electric lights a trial by taking ten of them, to be placed on Newark-avenue. The matter would not be definitely decided, however, till the meeting of the Commissioners about the 15th of this month.

The Irony of Fate.—As some of the members of the Mile End Vestry were discussing the question of introducing the electric light into their district, an explosion of gas occurred in the room in which they were sitting, the results of which are thus described in a daily paper:—"The chandeliers in both rooms and the windows were shattered to fragments, the window frames forced out, and nearly a dozen vestrymen thrown under the table. The ceiling of the room and the flooring of the housekeeper's room overhead were burst open. The damage done is estimated at £60 or £70. The Venetian blinds in the room catching fire added to the terror of the incident, but the flames were speedily extinguished." It appears that a slight escape of gas had been noticed in an adjoining room, and that on one of the servants pushing up the chandelier the explosion occurred. We are afraid that this accident will not inspire the unfortunate vestrymen with much liking for gas in the future. We are glad to say that none of them were seriously hurt.

The Edison System in New York.—We have received a copy of the *New York Herald* of recent date, containing an account of an interview between one of their reporters and Mr. Edison on the subject of a statement made by an anonymous writer in an American gas journal, to the effect that the Edison system was a failure, owing to defective insulation of the conductors and consequent leakage of the current. Mr. Edison's answer to this was "That's not so. That's printed only to amuse the stockholders of these gas companies." He subsequently handed over the reporter to Major Eaton, vice-president of the Edison Company, who explained to him that actual tests made over the fourteen miles of conductors laid only fell a trifle short of theoretical perfection, and demonstrated the fact that the whole net work, when in operation with 14,500 lamps in circuit, showed a loss of only 268 foot-pounds, or ·007 of a single lamp, which is only forty-eight millionths of one per cent. of the entire current used—a loss practically insignificant.

Stopping Engines by Electricity.—An ingenious method of instantly stopping machinery when in motion is said to be in operation at the Dominion Bolt Works, Toronto. A wire rope, coiled around the stem of the throttle valve of the engine, carries a weight which is held in place by a rest, and the whole arrangement is so placed that the passing of an electric current along a wire releases this rest, and causes the weight to fall. The tension thus thrown upon the wire rope acts upon the throttle valve, cuts off the supply of steam, and consequently stops the machinery. Buttons, with wire connections, are placed in different parts of the works, and on pressing any one of these the passage of an electric current acts as above mentioned. In any factory these electric buttons can be placed in every room, or several of them in a large room, as may be required. Should any one happen to get caught by the machinery, the simple pressing of a button in the most distant part of the factory will stop the whole as quickly as could be done were the engineer standing ready to instantly obey a given signal.

Protection of Cables.—According to *The Times* the International Conference relative to the protection of submarine telegraphs was to hold its fourth sitting on Saturday last (October 21st). The French Government had submitted to it a programme in three divisions:—(1) Questions relating to the protection of these cables; (2) regulations for vessels laying or repairing them; (3) questions affecting the rights of different companies. The conference had discussed the first and second divisions, and had appointed a sub-committee which had begun its sittings on Friday (October 20th) to draft a convention embodying its resolutions. There was a general disposition to follow the terms of the North Sea Fisheries Convention, which was signed at the Hague on the 6th of May last. The chief difficulties of the present negotiations are said to be as to the degree of negligence on the part of vessels or fishing boats which shall render offenders liable to punishment for injury to cables, and as to the courts before which the trial shall take place. It is expected that the conference will conclude its business about the end of the month.

Incandescent Lamps in Offices.—The Electrical Power and Storage Company has fitted its offices at 4, Great Winchester-street-buildings, Old Broad-street, E.C., with incandescent electric lights. The power is derived from a 1 horse-power Otto gas engine in the basement of the building, which drives a Siemens dynamo machine. The current is made to charge a Sellon-Volckmar accumulator of twenty-five cells. Each cell is about a foot square, and 5in. thick, and contains two compound leaden plates—one positive and one negative —with thin sheets of wood so disposed as to prevent contact between the two plates. The plates are perforated with holes about $\frac{1}{3}$in. diameter and $\frac{1}{8}$in. apart. These holes are plugged with a paste made of red oxide of lead. The cells are charged with diluted sulphuric acid. The ammeter of Ayrton and Perry indicates the strength of the current in the engine room, and an incandescent lamp there furnishes a clue to the manner in which the others in the series, but upstairs, are acting. When fully charged, it is said that the battery will supply thirty lights for ten hours. Swan's incandescent lamps are employed.

A Signal Balloon.—*L'Electricité* describes the following experiment, which was carried out by MM. G. Mangin, an aeronaut, and Cloris-Baudet, an electrician, at the residence of M. Egasse, a chemist, at No. 29, Rue de la Chapelle, Paris. A Baudet battery of 24 cells was arranged on a table in the middle of the courtyard of the house. A paper balloon, rendered impervious by a method invented by M. Mangin, had been inflated with pure hydrogen gas. In the interior of this balloon a Swan lamp was suspended by means of a string. Two wires were attached to the lamp and the battery, and then the mouth of the balloon was closed by a string. M. Baudet completed the circuit, and the lamp was lighted. The balloon, whose diameter was about 2·50 metres, appeared to be completely illuminated. The amount of light thus obtained was very considerable, and seemed to be certainly superior to that which can be obtained from the Swan lamp alone. M. Baudet then switched the current through a series of Swan lamps fixed in the courtyard, the effect being to extinguish the lamp in the balloon. He then again switched the current through the lamp in the balloon, thus showing that the system could be used for night signalling.

Electric Lighting in the City.—At the meeting of

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the Commissioners of Sewers on Tuesday last the consideration of the report of the Streets Committee on the question of electric lighting, and the notices from companies of their intention to apply for provisional orders under the Electric Lighting Act, 1882, was resumed. The report recommended that the solicitor be instructed to appear on the applications, and secure clauses protecting public and private rights. Mr. Pannell, chairman of the committee, moved the adoption of the report. An amendment was moved by Mr. Moore as follows:—"That the Commission become the undertakers for the supply of electricity under the provisions of the Electric Lighting Act, 1882, and do apply for a provisional order or license, as they may be advised, and that an intimation of their purpose be given to the Board of Trade and the companies and persons who have served notices on the Commission of their intention to apply, and that all other applications for provisional orders or licenses, so far as the City is concerned, be opposed accordingly." In the course of his speech Mr. Moore ridiculed the idea of allowing the power of supplying electricity to slip out of their hands. After some discussion the amendment was carried by 21 votes to 17.

An Electric Tricycle.—Recently inquiries appeared in our correspondence columns as to whether a tricycle could be lighted by electricity. We now learn that the improvements in the storage of electric energy and in electromoters have so far advanced that tricycles can not only be lighted, but also propelled solely by electricity, as was seen from the tricycle ridden last week by Professor Ayrton in the City. The Faure accumulators in which the energy was stored for the lighting and driving were placed on the footboard of the tricycle, and the motion was produced by one of Professors Ayrton and Perry's newly patented electro-motors placed under the seat of the rider. Using one of these specially made tricycle electro-moters and the newest type of the Faure accumulators, the total dead weight to be added to a tricycle to light and propel it electrically is only 1½ cwt., a little more than that of one additional person. In the tricycle ridden by Professor Ayrton the ordinary foot treadles were entirely absent, so that there could be no question as to electricity being the sole propelling agency, but with ordinary electric tricycles it may be desirable to leave the treadles, so that while electric propulsion alone is used on the level the rider can, on going up a steep hill, supplement it by using the treadles, instead of, as at present with the ordinary non-electric tricycle, having to get out and ignominiously push his tricycle up the hill before him.

The Electric Light in Shanghai.—The electric light has now been exhibited in Shanghai for nearly a month, says the *North China Herald*, and judging by the gratifying enthusiasm which the subject has aroused amongst the Chinese, we may expect to see the new light spread throughout the settlements as fast as the company can furnish the necessary power. The Shanghai Electric Company having successfully raised their modest capital of 50,000 taels, and in doing so being compelled to reject nine-tenths of the applicants for shares, mainly Chinese, at once set to work to erect the dynamo machine, the despatch of which from America had been previously arranged. There are now fifteen lamps working on the circuit; four at the China Merchants' lower wharf, rented by the company for the purpose of illuminating their frontage and enabling work upon vessels lying alongside to proceed as easily at night as in the daytime. The Astor House has in its restaurant, billiard and bar rooms three lamps. Sixteen lamps being the complement of the present machine, nothing more can be done to extend the light until the company's new 40-light machine is erected. The foundations for this and the 40 horse-power engine with which it will be driven are now being rapidly constructed, and before the end of the month the company will be in a position to respond to the numerous applications for private lamps which are being daily made to them.

Dr. Siemens on Waste.—On the occasion of the annual distribution of prizes to the students attending the science classes that have been held in St. Mary's Hall, Coventry, Dr. Siemens took occasion to say a few words on his favourite theme, "waste." "There were different kinds of waste," he said, "waste of time, food, personal energy, mechanical energy, and material. Those five kinds of waste, if they could not be avoided, reduced to inconsiderable proportions would constitute an enormous source of wealth. They must all confess to wasting, perhaps, two hours a day, and if the legislature could exact a tax of a penny an hour on that the National Debt would be paid in a very little time." After speaking of the waste of mechanical energy in a steam engine, and how the consumption of coal had been reduced from 10lb. per h.-p. twenty years ago to 2lb. at the present time, Dr. Siemens said that he had been experimenting with a steam engine at his farm at Tunbridge Wells, with the object of utilising all the heat produced. He explained that by means of a steam-engine, working a dynamo machine, he obtained, not only light in the evening in his greenhouses, but also artificial sun, which enabled him to grow fruit, such as melons, peaches, and strawberries, in the depth of winter. The steam from the engine was not lost, but it supplied heat to the greenhouses and other places in the winter, so that he did not expend much more fuel since he started the electric light and dynamo machine than he did before in heating those houses.

Construction of Telegraph Lines.—Tenders are invited by the Government of the Orange Free State for the supply of material and the erection of the following telegraph lines in the Orange Free State, South Africa:—Between Winburg and the Vaal River, *viâ* Ventersburg; Kroonstad and Heilbron, between Winburg and Ladybrand, between Senékal and Ficksburg, and between Wepener and Smithfield. No tender will be entertained unless for the whole of these lines. The probable aggregate mileage of the lines combined will be about 350 miles, more or less. The average number of poles required per mile will be about 13. The percentage of No. 8 (straining) posts will be about 6 per cent. The tenders will have to state the price per mile, including furniture, stores, &c. The whole of the work to be completed within twelve months from the date of notification of the acceptance of the tender, either by telegram or by letter. The contractor or contractors will be required to give security to the satisfaction of the Government, to the amount of £5,000 (English currency), for the due performance of the work and adherence to the specifications. The Government will, at its own cost, have the lines surveyed and pegged out. Copies of the field book will be supplied. Specifications are to be seen at the offices of the different Free State Consuls—in England, at London; in Germany, Berlin and Hamburg; in Holland, Arnhem; in Belgium, Brussels; in France, Paris; in America, Philadelphia; and at the office of the Government Secretary, at Bloemfontein, Orange Free State. Tenders to be sent or addressed to the Government Secretary of the Orange Free State, Bloemfontein, by 12 noon on the 30th December, and be marked "Tenders for the Construction of Telegraphs, Orange Free State." The Orange Free State Consulate is at 17, Gracechurch-street, London, E.C.

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CORRESPONDENCE.

A TELEGRAPH LINE WITHOUT INSULATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In 1873, while engaged as superintendent of telegraphs for the Imperial Government of Japan, I built a telegraph line of nearly 200 miles between Nagasaki and Shimonoseki Straits, South-west Japan. Being without insulators, I simply stapled the wire to the poles, which worked admirably. Being also without sulphate of copper, or any kind of acids, for my battery, as an experiment I tried pure rain water only. For each circuit I used 20 Daniell pint cells for the line and four cells for the relay. There were four stations, each from about 40 to 80 miles apart. Siemens' Morse instruments were used, and not the slightest failure was perceptible during four months, when a supply of insulators and battery material arrived. Although the current was somewhat feeble, we managed to work off 20 words per minute.

The atmosphere of Japan is very clear and perfectly free from mineral poisonous smother, in which respect it has the advantage of European countries.

At each large station rain water is used exclusively for battery purposes; previously the water obtained from rivers and wells contained lime, iron, sulphur, and other bad impurities, causing a local action to set up, hence the rapid destruction of the zinc and copper plates. With rain water there will be found little or no local action, and the expense is simply one half. Each cell should be kept separate, and never allowed to contact, as when damp weather sets in the cells sweat, and become thickly crusted with salts. The porous cups are often choked with sulphate crystals, or salamoniac, which entirely cements the copper and zinc straps to the cells or cups, and when the time arrives for cleaning the cup has to be broken before the straps can be extricated. This is simply false economy. Battery men labour under a sad mistake, that the more crystals they can force into the battery the greater the power is obtained.

Four ounces of sulphate, or 3oz. of salamoniac, the size of a gipsy nut, is ample for each cell, and one or two ounces of the same repeated weekly, with the use of rain water, will keep the battery perfect on an express or circuit for at least three months. If rain water be unobtainable other water should be boiled.—Yours, &c.,

JAMES V. FRY.

THE EARLIEST GAS ENGINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the paragraph headed "An Early Gas Engine," in your last issue, you quote the *Scientific American*, published in 1846, in which it is shown that a gas engine was invented as far back as 1843. It may interest your readers to know that the first gas engine—or at least one of a much earlier date—was patented in this country by a Mr. Brown in 1824. The following is an extract from "Boyle's Chronology," date 1824:—"The invention of the gas vacuum engine will supersede the use of steam in working machinery. Mr. Brown's engine was examined by many scientific characters, and its efficacy universally acknowledged, and he obtained a patent for that invention."—Yours, &c.,

ALEXANDER WATT.

INFORMATION WANTED.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I wish to make a dynamo on the pattern of Siemens's smaller machine. Can any reader give me weights and sizes of wire on armature and field magnets, both as used for arc and incandescent work, with the formulæ for calculating same?

It is said that wires must be of sufficient size to bear without heating double the current usually required. What temperature is it permissible to raise wires to, and how is the required area calculated?

Is there any reliable rule for calculating the candle-power of an incandescent lamp from the surface of the filament, and what effect has the sectional area on the candle-power?

Any information on the above will greatly oblige

REVIRESCO.

ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In addition to the discussions on the merits of rival dynamo machines and lamps, the public is likely to be further distracted by the claims of patentees to the sole right of doing everything in connection with electric lighting.

Mr. Edison disputes the right of any one to use incandescent lamps other than those covered by his patents; and now Mr. Lane-Fox claims the privilege of lighting by a plan combining the use of dynamo machines, secondary batteries, and incandescent lamps in multiple arc.

This Company gives to the world a better method of doing the same thing by secondary batteries *in series* and lamps from those batteries in multiple arc.

All these claims and differences among the doctors will probably cause town councils and other local authorities to pause before embarking upon the business of electric lighting, under Board of Trade licenses or provisional orders, and leave the development of the enterprise in the hands of the various patentees and their concessionaires.—Yours, &c.,

GEO. OFFOY,
South Eastern (Brush) Electric Light
and Power Company (Limited).

Oct. 21, 1882.

A GUIDE TO PRACTICE IN THE SUBMARINE CABLE TESTING ROOM.

VI.

We have taken leave of the electrometer for the present, proposing to return to the employment of that instrument as well as of the Wheatstone bridge when some further progress has been made in the ordinary routine course of testing. The test now to be considered is that for determining the capacity of a cable.* The remarks made in No. IV. of this series on the subject of the electric potential will have rendered it easier to understand the meaning of this term, which, in some sense explains itself. The learner will perhaps hear this test styled indifferently a test for the electrostatic capacity or the inductive capacity of a cable, and so it is called in books treating of electrical measurement. But, speaking with a strict attention to the conditions which govern what is called the capacity, it is incorrect to assume that these expressions mean one and the same thing. *Electrostatic* capacity applies to the copper conductor, and *inductive* capacity is a quality of the gutta percha or insulating cover of the cable. The electrostatic capacity is also the *charging* capacity, and depends upon the inductive capacity of the insulator or *dielectric;* thus, although not the same thing, they are intimately related, and both are greatly affected by a change in the position of a cable, as when it is under water at one time and suspended dry at another.

That these terms "electrostatic" and "inductive" cannot be correctly used as having the same meaning or application may be inferred from the composition of the words themselves. The former has reference to electricity in a *static* or settled condition—as on a suitable surface—and referring, therefore, in the case before us to the copper conductor which is prepared to receive it. The latter expression conveys the idea of an attraction or an inductive property tending to induce the settled electricity to change its position.

A submarine telegraph cable is in regard to its electrical properties a very large *condenser*. A condenser, in electrical science, is an appliance or apparatus for accumulating a large quantity of electricity on a comparatively small surface, as first exemplified in the Leyden jar. Whatever be the form of a condenser, it must consist of two conducting surfaces,

* Perhaps we ought to have said that the word "cable" in these papers will always mean a submarine telegraph cable, though used by itself.

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separated by a dielectric or non-conducting medium which tends to prevent the electricities on the opposing surfaces (or surfaces in opposition to each other) from recombining—that is, when neutral or undeveloped electricity has become active by separation at the source, such as a battery. The student will have learned from his earliest acquaintance with electrical science what this means, as when positive and negative electricities are separately produced or discovered on two surfaces rubbed together, a glass rod and a piece of flannel, &c.

The remark just made about induction tending to induce or lead away the settled electricity on the conducting surface does not contradict this statement that the dielectric opposes the recombination. The dielectric has an induction quality, or capacity, and consequently a quality of resistance. The one is the necessary consequence of the other. A feeble inducing power means a strong resisting quality, and *vice versâ.*

In a Leyden jar the tinfoils on the inner and outer sides are the two conducting surfaces, and the glass between is the dielectric. In the condenser, as used in the testing room, the conducting surfaces or plates are of tinfoil, and between each pair a sheet of mica in some forms, and paraffined paper in others, forms the dielectric, the non-conducting surface. In a cable the copper conductor and the outer sheathing answer to the tinfoil sheets in the Leyden jar and the tinfoil plates in the condenser, whilst the gutta percha covering is the dielectric, of course, and corresponds with the glass and paper or mica of the Leyden jar and condenser. In Fig. 10 A and C in both cuts are the two conducting surfaces (and, therefore, practically the poles) separated by B dielectric for the condenser and cable.

Condenser.
A and C Poles.

Cable (Section). Also a Condenser.
A and C also Poles.

FIG. 10.

But though this is the case, a cable differs from a condenser as to its existent conditions, owing to the fact that the earth forms one of (or part of one of) its conducting surfaces when it is on the ground or under water, and is only fairly analogous to it if it be suspended in air, as hinted above. On this point depends a matter connected with the use of condensers which it is important to bear in mind, and which the learner will later on find interesting as bearing on the question of testing cables under certain conditions. This point is simply that one pole of a condenser must be put to earth when testing its capacity or using it to any good purpose, for otherwise we should find it would take up little or no charge. The poles of a condenser are represented by two brass terminals, which the learner will see on the top of the box, whatever the form may be. They are the terminals of the two conducting surfaces, and in saying two we do not mean that there are only two plates, but there are practically two, though really there may be hundreds. The simplest form would consist of two plates separated by one dielectric, say of oiled paper (see Fig. 10). By joining alternately any number of such plates, the first to the third, the second to the fourth, and so on we should have two separate large surfaces for accumulation of electricity, the total size of each depending on the number, and a large surface of dielectric made up of so many continuous portions of paraffined paper or whatever it might be (see Fig. 12). To the first and last of the plates conducting pieces lead to the two terminals outside, and these are the poles. In the figure A and C may be the poles. This diagram is merely offered to show the principle, and is not true either to proportions or form. If we were applying the term "poles" to a cable one would be the end of the copper conductor and the other would be the outer sheathing at any point in its surface. In using this expression it is not intended altogether to suggest the idea of such poles as those of a magnet; these latter signify two ends, each having a distinct and opposite character. The poles of a condenser are more properly the two sides. A consideration of the true meaning of electrical induction will confirm this position.

As we have just seen, the union of a large number of conducting plates in a condenser affords a comparatively large surface for accumulation, and in like manner the dielectric is much enlarged, but when we come to consider the *thickness* of the latter we must not mistake the effect of repeating the layers and look at them as if it were a mass having the diameter of the whole. The thickness of the whole of the dielectric is measured by the distance between any two conducting plates. The inductive effect or capacity, to speak truly, is to be taken

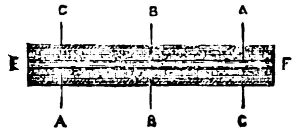

FIG. 11.—E to F, length for Accumulation varies with length of Cable. Length for Induction is the thickness of B constant.

as so much for every part of the accumulating surface of the conducting plate. The former, then, governs the inductive capacity, and the latter the electrostatic capacity of the condenser. In the same way, regarding a cable as a condenser, the conducting surface for any given length or at any point measures the electrostatic capacity for that portion, and the whole of the conductor from end to end has a total amount of surface depending on the length, whilst the inductive capacity is measured by the thickness of the dielectric at any point, being uniform throughout. We might correctly say, "A cable has a total electrostatic capacity of so much," but its inductive capacity can scarcely be spoken of as a total, because it is so much per unit of length. Take a piece of cable, as in Fig. 11, and for any portion as the half we can say it has an accumulation surface of so much for each half and of double that amount for the whole. But the total inductive capacity is only so much for every point in the conducting surface or the under surface of the dielectric.

We have been thus particular in discussing the condenser

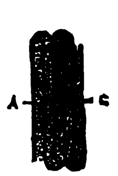

FIG. 12.—Condenser Plates. Plan of Joining.

in order to impress on the student's mind the conditions governing its use. To measure the capacity of a cable we must have some standard to which to compare it, and as the condenser is our standard it is well that it should be fairly understood.

We mentioned above that in using this instrument one pole must always be to earth, and shall now proceed to give the reason. When a condenser is charged, say, with positive electricity from one pole of a battery, the other being to earth, an attraction is set up between the opposite or opposing plates. It is called "induction" because the plate directly charged, being in connection with the battery or source of charge, induces electricity of the opposite kind on the opposing plate. This acts across or through the dielectric separating the plates. As various substances afford different facilities for induction through them, there will be greater or less resistance to the action according to the nature of the dielectric and some other conditions

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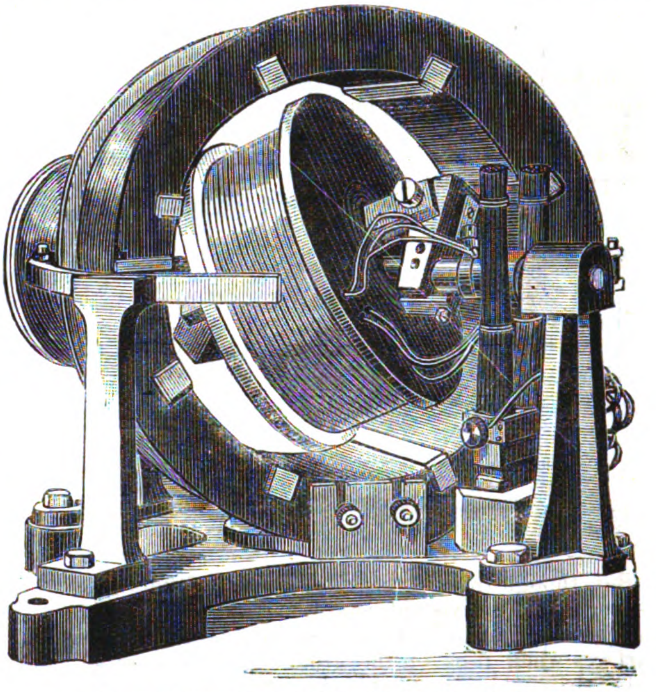
which may be omitted for the moment. Now, the amount of charge that can be accumulated upon the conducting surface from one battery pole depends on the inductive capacity of whatever dielectric separates it from the opposite or opposing conducting surface, which is, it must be remembered, also in connection with or acted on by the other battery pole, since this other pole is to earth. If the opposing plate of the condenser be put to earth there is a direct communication from the two poles of the battery to the two poles of the condenser, and the resistance to induction is then that offered by the dielectric. If it be a cable the gutta percha is the dielectric, and that alone may be said to resist the inductive action. But if the opposing plate of the condenser or the outer sheathing of the cable (which we showed above forms one pole of the cable as a condenser) were insulated, that is, cut off from direct communication with earth, then the gutta percha would no longer be the only medium for resisting the inductive action. Supposing the cable to be perfectly free from earth communication throughout its length, the induction would have to act across the gutta percha with the addition of another and more highly insulating medium, namely, the air. The fact is that, as Mr. F. C. Webb was the first to point out, wherever *accumulation* of electricity on a conductor takes place an inductive circuit is established as truly as when a conductive circuit is set up in the case of a *current* of electricity. This extends from one of the conducting surfaces across the dielectric to the other, or, as in a cable, across the dielectric to one side of an intermediate conductor, the other side of which is separated by a dielectric from the other opposing surface, in this case the earth. The dielectric, therefore, forming part of that circuit in every case offers resistance to the induction, and facility for accumulation is offered when the inductive resistance is less, and *vice versâ*. As when the cable is insulated by being (supposing it possible) suspended free in air along its length, but little accumulation can take place by charging, so by putting its outer surface to earth an increased quantity of electricity can be accumulated, because now the inductive circuit has metal for a portion of its path, and a considerably reduced length (in thickness) of dielectric. In this case the thickness is to be taken in the sense of length as being a part of the inductive circuit or path. So with the condenser—instead of a dielectric of air a metal path is supplied when it is put to earth—greatly decreased inductive resistance is the consequence, and electrical accumulation vastly facilitated, and thus increased. An observation of the Figs. 10 and 11 may serve to bring out the conditions more clearly. From a supposed battery having one pole to earth, the other pole charges the inner conducting surface A with positive electricity. Now, in every case of electrical action equal qualities of opposite kinds of electricity are produced. This is true whatever theory be preferred; so from the other battery pole (that to earth) negative electricity is produced or separated, and is distributed on all surrounding surfaces in connection with that side. But, leaving aside the question of its distribution, an inductive circuit is established between the two sides of the battery or the two opposing surfaces which are connected with them. The circuit is from A through the gutta percha to the inner side of the sheathing, and from its outer side, C, through the air if the cable is insulated; but if on the earth or in water the circuit is through the gutta percha to earth, since that is practically the conducting surface. For a condenser it is just the same. If a cable be covered with water the inductive resistance is much less than when it is dry, though lying on the ground, because water is a worse dielectric than dry earth (presents less dielectric resistance), and then it envelopes it at every point of its surface. If dry, great part of that surface has air round it.

The learner will now understand pretty well what a condenser is, and why it is employed as a standard for measuring the capacity of a cable. The foregoing remarks aim at giving an outline of the subject. We cannot here carry our theoretical explanation further, but hope it may be useful in showing the principles governing the course followed in this and other tests. In the next number the practical operation will be considered.

THE ECLIPTIC ELECTRIC MOTOR OF M. PAUL JABLOCHKOFF.*

This motor is composed essentially of two coils, one fixed and arranged in a vertical plane, the other movable and fixed on a horizontal axis in an inclined position; it is to this inclined position, which resembles that of the ecliptic on the equator, that M. Jablochkoff's motor owes its name. The fixed vertical coil is not, as heretofore, in a vertical plane perpendicular to the axis of rotation of the motor, but it makes with this plane a certain angle determined by experiment and which depends on the conditions of working of the apparatus.

The fixed coil is wound on a body of copper. The movable coil is established on a framework of iron which, under the influence of the current which traverses it, is transformed into a short electro-magnet, of which the poles are formed by two circular discs. On the axis of rotation is placed a commutator against which four rubbing brushes bear. This commutator is so arranged that during the rotation of the arbor the movable coil is traversed by a current which never changes in character (sign), and maintains in the flat electro-magnet a permanent polarity, but at each half revolution the current is reversed in the fixed coil without soft iron. The motor



The Ecliptic. M. Paul Jablochkoff's New Motor.

works by the reciprocal attractions and repulsions of a movable permanent magnet and a fixed solenoid traversed by currents alternately of opposite character.

These reciprocal actions tend to produce a pivot motion of the movable electro-magnet placed inside the fixed solenoid. The part played by the commutator is to render these actions concurrent, and so produce a continuous movement. M. Jablochkoff's motor is reversible, that is to say, that if it develops mechanical work by the expenditure of electricity, it is also capable of generating electricity by the expenditure of work.

We may remark here that though the arrangement of the ecliptic motor appears to us to be new and original, the idea of giving a fixed polarity to the movable part furnished with an iron armature, and of reversing the current in the fixed part without iron, has already been anticipated by M. Bürgin, of Basel, in a motor which was shown at the International Electrical Exhibition of 1881, and to which the inventor gave the name of the spherical motor, by reason of its form.

The experiments made by the firm of Breguet on the Jablochkoff motor not being yet finished, it is not possible to ascertain its value as regards effectiveness.

* Translated from an article by M. Hospitalier in *La Nature*.

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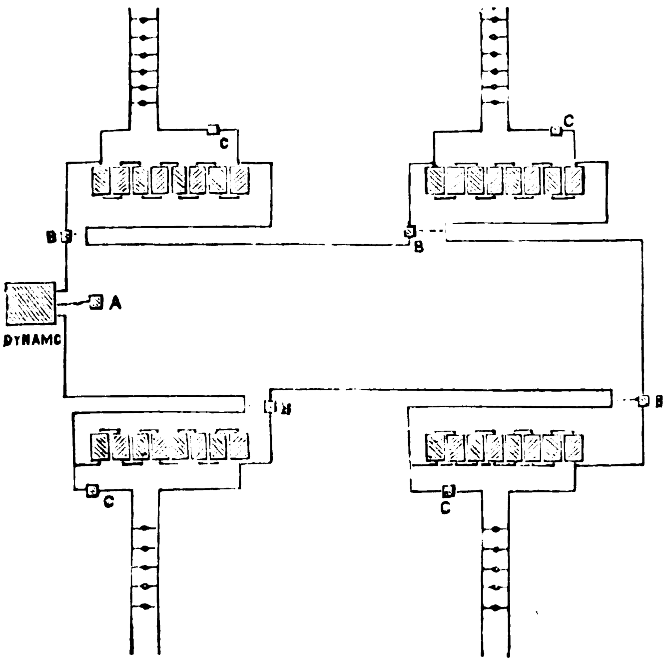
THE "B.T.K." SYSTEM OF ELECTRIC DISTRIBUTION.

We have been presented with a copy of the circular issued to the shareholders of the South Eastern and Provincial (Brush) Electric Light and Power Companies (Limited), and also a block plan and general description of the mode of the B.T.K. system of electric distribution, invented and perfected by the electricians to those companies.

It has not been patented, as they considered that the electric light in general should not be hampered by such means.

Referring to the block plan, A shows the position of the automatic regulating apparatus, so constructed as to keep the current of electricity constant whilst being used for charging the accumulators, which may be situated any distance from the dynamo up to thirty-five miles. And should the dynamo be used for running the lamps direct from the machine, this regulator keeps the E.M.F. constant, thereby keeping all the lamps at the same brilliancy, independently of the number of lamps burning. This apparatus enables engines to be utilised that could not be employed under any other system, as it counteracts the effects of variations in their speed.



The "B.T.K." System of Electric Distribution.

By a peculiar automatic apparatus situated at B only the proper quantity of current is allowed to enter the accumulator to supply the amount used since the previous charge; this apparatus is also a meter for registering the quantity of current supplied.

At C is an automatic contrivance for keeping the E.M.F. constant, whatever number of lamps may be turned on or off inside the dwelling house in which the accumulator may be fixed.

It will be noticed that the system is that of charging the accumulators *in series*, and it will be understood from the previous description that as any accumulator becomes charged the apparatus B cuts this accumulator out of the series until some of the current has been used, when it brings the accumulator into the circuit again.

It will also be seen from the diagram that the lamps are worked direct from the accumulators in multiple arc, and the apparatus C keeps the E.M.F. of current passing to the lamps constant, through proportioning the resistance of the external to that of the internal resistance of the accumulator.

These are the principal points of the system, but it also comprises many other minor apparatus.

NOTES ON PRACTICAL ELECTRICITY.*

The work I have had in hand for some time past has been the design and construction of clock-regulated uniform-motion machines. As to these, I will only say that the constructions formerly described by me have been entirely superseded by a new design. This is not yet in a state of sufficient forwardness for description, and I propose to reserve it for another occasion. The working of these machines is dependent on the application of a considerable amount of electrical power. After seeing the Paris Exhibition I decided that in all probability a dynamo machine would be a better source for laboratory purposes than batteries, which are in my opinion a nuisance, and subject to most serious defects when used on the large scale. I accordingly set up an A Gramme machine. I also have made a set of accumulators. The practice of the employment of these instruments for ordinary purposes gives rise to numerous points of interest; and I propose to give a short account of my experience.

The laboratory steam engine is able to supply sufficient power to give a powerful electric light from the machine. I take it that under these circumstances about $2\frac{1}{2}$ horse-power are absorbed altogether. The nominal horse-power of the engine is 2. It is scarcely sufficient to develop the full power of which the dynamo is capable; but for laboratory purposes it is quite sufficient.

The A Gramme machine has four electro-magnets, two above and two below, whose axes are in one plane. In the same plane is the axis of the Gramme ring armature. The resistance of the machine is about 1·2 ohm.

The magnet-wires are directly connected with the armature brushes; and the terminals receive the wires after each has passed through two magnets. Consequently all currents have to pass through both magnets and armature, thus:—

```
Magnet———Armature———Magnet
  |                   |
Magnet              Magnet
  |                   |
Terminal           Terminal
```

For purposes which will be presently described, it was found necessary to be able to separate the magnets from the armature. The wires were, therefore, cut, by which means the following combinations were obtained:—

```
      —Magnet-terminals—
     |                  |
Magnets—Armature—Magnets
            |      |
     Armature-terminals
```

and

```
 —Magnet-terminals—
|                  |
 ————Magnets———————

 ———Armature————
|               |
 —Armature-terminals—
```

In which last arrangement the magnets are separately excited. There are other forms, which will be described presently.

The resistance of the magnet circuit is about ·75 ohm. That of the double course through the armature is therefore about ·45 ohm, the total resistance being taken at 1·2.

The terminals are marked + and — respectively. When the machine is acting in correspondence with these indications, I call it "straight," and the upper pole-pice attracts the unmarked end of a compass-needle. The residual magnetism is very strong. I think the whole of the solid part is probably made of cast-iron.

When the polarity gets reversed from any cause I call it "reversed." In this case the upper pole-piece attracts the marked end of a compass-needle.

* By R. H. M. Bosanquet, Fellow of St. John's College, Oxford, in October number of *Phil. Mag.*

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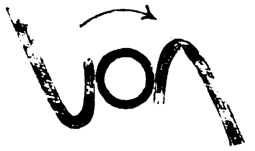
The directions of currents and rotation deserve some attention.

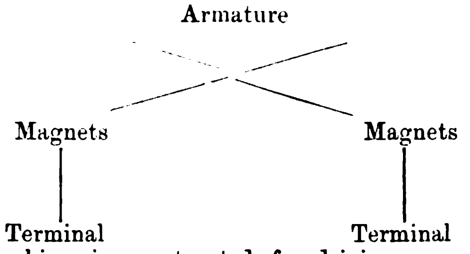
The machine is driven in the direction opposite to that of the hands of a watch, regarded from the pulley-end. It gives currents in the one or the other direction, according as it is "straight" or "reversed." This is obvious, for with reversal of the current both field-magnets and armature are reversed, and the attractions which have to be overcome in doing the work remain the same.

When a current is sent through the machine from a battery it always turns in the direction opposite to that in which it is driven by the engine; for whichever way the current goes the attractions are the same as in the former case, and as these are overcome by the engine in that case, it is clear that they tend to turn the machine in the opposite direction to the engine.

When the machine is driven by a battery, with the hands of a watch from pulley-end, it is necessary so to adjust the brushes that their ends may not catch in the commutator. I turn up the ends of a spare pair of brushes, and apply them to the commutator in this manner.



Otherwise the machine can be caused to turn in its normal direction when driven by a current, by reversing the connections between armature and magnets; this is made possible by the cutting of the wire above described. The arrangement may be formulated thus:—



The machine is constructed for driving one arc light. Although this is not a matter with which I am directly concerned, the normal conditions may be of interest:—

Serrin lamp.
Revolutions about 900 per minute.
Current about 20 amperes.
Difference of tension between lamp terminals about 40 volts.

These are the highest values obtained under favourable circumstances.

According to these numbers the resistance of the arc is about 2 ohms; that of the machine and connexions is about 1·5.

This corresponds to 800 volt-amperes, or rather more than 1 horse-power, in the light itself (1 horse-power = 746 volt-amperes).

We observe here that little more than half the power expended is developed in the lamp.

Circuits of High Resistance.

Suppose I take a single British incandescent lamp (150 ohms cold, and about 80 ohms hot), the machine only just raises it to a red glow, though a speed of as much as 2,000 revolutions per minute be employed. The current developed is much less than 1 ampere.

Here the high resistance kills down the current, and prevents the proper excitation of the field-magnets. Hence the advantage in this case of machines in which the magnets form a shunt circuit of high resistance. It is easy to excite the Gramme machine by putting the magnets into a shunt circuit with a suitable resistance; but if a resistance-wire be employed, the power developed in heating it is wasted. I have, therefore, in many cases adopted the plan of putting useful work into the shunt-circuit of the magnets. This may sometimes with advantage consist of a number of incandescent lamps in parallel circuit. Substituting for this a certain number of accumulator-cells, we have the origin of a useful method which I call charging in balanced circuit, to which I shall return.

Galvanometers.

The galvanometers I employ were made in the laboratory. They are of a simple character, but quite sufficient for practical purposes. There are three of them.

Tension Galvanometer.—A circular wooden channel about ·11 m. radius, wound with wire of which 1 metre = roughly 10 ohms. Resistance = 2,900 ohms. This had its constant determined by reading the current from 9 Daniell cells, which are taken as representing 10 volts. Resistance of Daniell cells determined and allowed for. For high tensions a further resistance of 5,000 ohms is interpolated in the galvanometer circuit. Brass dial 3in. in diameter divided to degrees. Short steel needle with long pin points. 50deg. on the galvanometer, with the 5,000 ohms external resistance, corresponds very nearly to 50 volts. Other readings by the tangent-law.

Two Quantity Galvanometers.—These consist each of a ring of gun-metal, ·11 m. radius; the conductors leading to them are copper, and of tube-and-core form; brass dials, and steel needles with long pin points as before.

When dealing with large currents I placed a steel magnet under one of these, so as to convert it into a high-quantity instrument. Its constant was ascertained by sending the same current through both instruments, the one without the magnet reading as a tangent galvanometer in absolute measure.

Measures.

Although numerous measures of dynamo machines have been published, the laws of any given machine cannot as yet be predicted; and a few measures are given which are sufficient to illustrate the general course of the performance of this machine under different circumstances.

First, we will consider the cases where the governor was used. This may be taken to give 840 revolutions in all cases, except where, the resistance being 3 ohms or less, the leverage against the engine was such as to reduce the speed materially.

Resistance in parallel circuit with lamp. Ohms.	Tension between terminals. Volts.	Quantity. Amperes.
7	24·5	3·8
6	31·4	5·5
5	37·9	7·6
4	41·0	10·5

With lower resistance the speed cannot be maintained without taking the governor off. In considering the total electromotive force developed, of course the whole resistance of the circuit must be considered. The resistance of machine and connections may be taken at 1·5. Then, multiplying the current by the whole resistance, we should have the total electromotive force.

The work of Meyer and Auerbach leads for a given speed to equations of the form $\theta = a\,E - b$, where θ is an angle whose tangent is the measure of the current, and E the total electromotive force. I used the expression at first as it stands; but now I think it better to eliminate E as follows:—

Putting E = C R, the above form gives $C\,R = \dfrac{\theta + b}{a}$, or, $R = \dfrac{\theta + b}{a\,C}$, where R is the resistance of the circuit, C the current, and θ the angle of a tangent-galvanometer by which the current is measured.

To apply this to the above observations we find the following values of the total resistance, current, and θ:—

R.	C.	θ.	$R = \dfrac{\theta - 20}{C}$.
7·9	3·8	50°	7·9
7·0	5·5	60	7·3
6·2	7·6	$67\frac{1}{2}$	6·2
5·3	10·5	73	5·1

(When calculating the resultant resistance of the parallel

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circuit, we notice that it should be the same as the quotient of the observed tension by the current. It does not differ in any case by more than one or two tenths of an ohm. This is sufficient, considering that no special accuracy was aimed at. Further, it must be remembered that the wires of the resistance are nearly or quite red hot under these circumstances, so that some discrepancy is to be expected.)

Calculating R from the formula

$$R = \frac{\theta - 20}{C},$$

we obtain the numbers in the last column.

The result is tolerably satisfactory; but it is of little practical use where the motor employed is a steam engine capable of considerable variations of speed. With a gas engine, or other motor of very constant speed, the above method of finding the approximate resistance for a given current would probably be useful.

But with my engine, when the governor is not used, the speed adapts itself to the work to be performed; so that, within considerable limits, the only things to be considered are the amount of steam turned on and the work to be done. To illustrate this I will quote a series of experiments, in which the object was to maintain the tension necessary for a "British" incandescent lamp, which is about 80 volts, with different resistances in parallel circuit.

The least resistance with which this tension can be maintained is 5 ohms. It is easily seen that the resulting external resistance here is nearly four times that of machine and connections; so that the total E.M.F. would require to be 100 volts, roughly, to get 80 between the terminals. For smaller external resistance the total required would be larger; and this cannot be obtained. The load on the engine is heavy; full steam is required; and the speed is moderate.

Increase the 5 ohms to 6, leaving the steam as before. The engine runs faster, and the required difference of potential is kept up with about the same head of steam.

Increase to 7 ohms. Similar effect.

Increase to 10 ohms. The engine runs very fast; but the required difference of potential is still easily maintained. Of course here the total E.M.F. required is decidedly lessened.

As the resistance increases beyond this point, the speed required to maintain a difference of potential of 80 volts becomes too great for convenience, and by the time it reaches 20 or 30 ohms it becomes impossible.

In view of this power of accommodation, the question as to the precise resistance required to produce a given current at a given speed becomes of little practical importance.

The explanation of the power of accommodation is, roughly, as follows:—The total E.M.F. is to be supposed constant. In the preceding experiments it is not quite so being 100 volts, about, with the 5 ohms, and 90 or so with the 10. But the conditions of constancy can be realised; for with the 10 ohms I kept up the difference of potential of the terminals to 90 volts for some time, this corresponding to about 100 volts total E.M.F.; so that, in fact, this condition of constancy of total electromotive force can be attained through a certain range with a little attention.

Then the current developed follows Ohm's law throughout this limited range, with varying resistances; and the attraction between the magnets and armature depends on the current in each, so that a rough idea of the course of the values may be formed by assuming the attraction proportional to the square of the common current through both; and this is the reaction against the engine. Consequently as the resistance in circuit increases the current diminishes (Ohm's law), and the statical resistance to the engine diminishes, as we suppose for the moment, in the square of the ratio of increase of resistance in the circuit. Of course, the real values of the attraction depend on the magnetisations of magnets and armature; but the above accounts in a general way for the increase of speed produced by introducing additional resistances into the circuit. The increased speed is then utilised in obtaining the same electromotive force from the diminished current, or rather from the diminished magnetisation.

It will be readily seen how importantly this power of accommodation may be utilised in the practical treatment of such a question as the variation of the number of incandescent lamps on a circuit. Take the case of lamps of 70 ohms. Then 7 of these in parallel circuit constitute a resistance of 10 ohms, and 14 one of 5 ohms. Between these limits the tension might be kept nearly constant by the automatic variation of speed above mentioned. I do not say that this is the best way of attaining the result; but with means such as I possess it is a valuable auxiliary. I believe as many as 25 such lamps can be driven from the A machine; but this must require far greater power than is at my disposal.

Accumulators.

I have made 21 cells with lead plates coated with red lead, and 9 of another kind, which I will describe presently. In all cases the plates are wrapped in canvas. The lead I employed was 2lb. to the square foot. Each plate is about a square foot in size, and the red lead plates have 1lb. of red lead on each surface. The tags at the end were left rather narrow. I found lately that all the tags of the oxidised plates were so eaten away at the surface of the acid that they had to be replaced. I now use lead 3lb. to the square foot for oxidised plates. The tags are left 3 or 4 inches broad, and they are additionally thickened at the junctions by burning on a piece of lead on each side. They are also varnished.

These cells were "formed" by charging in the same direction every day for a considerable time. The maximum efficiency was reached in about a month, after which no further improvement was perceived.

These cells do not pretend to the excellence which is said to be obtained by the cells of the Faure Company. If left charged for any time, the sulphuric acid is rapidly and completely absorbed, leaving the water quite sweet, and considerable quantities of sulphate of lead are formed. This is slowly decomposed by fresh charging; but in the mean time it appears to isolate large portions of the active material, and considerably impairs the efficiency. I am informed that this local action does not take place with the cells supplied by the Faure Company. The red lead on the hydrogen plates becomes reduced to metallic lead, and that of the oxidised plates changed into black peroxide.* It is not until this change is complete that the cells attain any considerable efficiency.

The cost of the construction is very considerable. I have little doubt that they have cost me, on the whole, as much as if I had bought them at the very high price charged. But much of the expense could have been avoided. As it was, the original construction cost under £2 per cell. About half the outlay went to provide the wooden cases lined with lead. If stoneware jars could have been procured, I think one third of the original cost might have been saved. The "forming" of the cells with the small power at my disposal was expensive. I have not estimated the cost; no doubt it could be done very much more cheaply on the large scale.

The best return I have ever obtained amounted to about one half the power expended. This was obtained after a charge of short duration, the cells running one Swan lamp. The current and tension were measured at intervals. The return was about 70 per cent. of the electrical charge taken, and, as I judge, about half the total power expended. But this is by far the best return I have ever obtained. As a rule, the return is only a small fraction of the power expended.

The other nine cells are made with amalgamated plates of lead, and "formed" by charging in opposite directions in the manner practised with Planté batteries. These have less capacity than the red-lead cells, and are troublesome to form; but, on the whole, I am inclined to prefer them for laboratory purposes to home-made red-lead cells. They are much less trouble to put together, and do not suffer from local action.

Having cells of different kinds in the system is a great inconvenience. When the red-lead cells have suffered from

* I am indebted to Mr. Fisher, of the Oxford University chemical laboratory, for the examination of samples of these substances. The metallic character of the reduced substance was proved by amalgamation with mercury. The peroxide contained very nearly the proper quantity of oxygen, but fell a little short—not more than would be explained by inevitable impurity.

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local action they increase their resistance; and if systems of balanced charging are employed, in which two or more circuits are used, a progressive change takes place in the distribution of currents, which requires constant watching. It should be a first principle that all the cells should be as similar as possible.

The red-lead cells have eleven plates in each cell, the others fifteen.

With all their imperfections these cells are extremely useful for laboratory purposes; and as this was my object in constructing them, I am, on the whole, satisfied with their performance.

(TO BE CONTINUED.)

ON THE INFLUENCE OF SURFACE AND OF MASS UPON THE RADIATIVE POWER OF AN INCANDESCING FIBRE.

BY ALFRED W. SOWARD AND I. PROBERT.

In analysing the conditions of success in the construction of an incandescent electric lamp, we have been forcibly impressed with the necessity of attention to the principle of variation of intensity of radiation with variation of extent of radiating surface (and also with variation of the mass in which the heat is generated). As we have nowhere seen this necessity insisted upon, we offer the following remarks for the consideration of those interested in the subject of electric lighting.

To make our meaning quite clear, let us imagine an experiment made with two incandescent lamps joined in multiple arc to a suitable current generator, and having fibres of equal resistance and of equal mass, the one cylindrical in shape, the other broad and thin. The fibres being of equal resistance*, the current will divide itself equally between them, and the quantity of heat generated will, consequently, be the same in each. The amounts of energy radiated from the two fibres will (except during a short period immediately following the lighting of the lamps) also be equal; for, if more energy were radiated from one than from the other, there would be implied the creation of energy in the one, or the indefinite accumulation of energy in the other, neither of which is possible. But here the parallelism ends.

The same amount of energy being radiated in a given time from each fibre, it follows that the amount of energy radiated per unit of surface must be greater in the fibre of smaller surface (that is the one of cylindrical shape) than in the one of larger surface. The greater radiation per unit of surface is accompanied by—is, in fact, caused by—a rise of temperature. In the fibre of smaller surface the heat cannot so easily escape. It tends to accumulate, and, to some extent, does accumulate. In so doing it raises the temperature of the fibre; and, by the very act of raising its temperature, increases its radiative power. When the radiative power has been adequately increased by the rise of temperature, equilibrium is produced between the heat generated and the energy radiated, and the temperature remains constant. The temperature is higher than in the case of the fibre of larger surface. Although the energy radiated by the two fibres is the same, the light resulting from that radiation is not. The light depends not only upon the total amount of energy liberated, but also upon the intensity of the radiation, and the intensity of radiation depends upon the temperature. But the temperature we have seen to be greater in the case of the fibre of smaller surface than in that of the one of larger surface; therefore, the light will be greater in the former than in the latter. By increasing the surface of the fibre (always keeping its resistance and mass the same), it would be possible to so reduce its temperature, that, although it radiated the same amount of energy as before, it would not be even visibly red.

It follows from this that the device patented by a well-known inventor of flattening a carbon fibre, so as to increase the radiative surface, defeats its end by lowering the intensity of radiation. It follows also that the practice of enclosing several fibres (in multiple arc) in one lamp, or (which amounts to the same thing) the clustering together of several single fibre lamps in one enclosure, as practised by another inventor, is wasteful of energy; for a single fibre lamp, having a mass and resistance equal to the combined mass and resistance of the several, could be constructed with a much smaller radiative surface.

The above reasoning, considered alone, would seem to suggest the sphere as the proper form for the "filament" of an incandescent electric lamp; that being the solid which, for a given mass, has the smallest surface. Let us see whether the principle of variation of intensity of radiation with variation of the mass in which the heat is generated points to the same conclusion.

If a fibre of spherical shape were taken, having the same mass as our other two fibres, its surface would, as stated above, be smaller than that of either, but its resistance also would be less. Remembering that the resistance of a sphere varies inversely as its diameter, it would only be necessary to decrease the size of the sphere and the lost resistance would be regained. The surface of a sphere varying as the square, and the mass as the cube of the diameter, it follows that this decrease in size of the sphere is accompanied by a decrease in both its surface and mass. The first is advantageous as we have seen. That the latter is so also will appear, if we consider that a given amount of heat generated in a small mass will be more concentrated, and will produce a higher temperature, and consequent higher intensity of radiation, than if generated in a large mass.

It follows, therefore, from consideration of the two principles enunciated above, that the sphere is the best form for the "fibre" of an incandescent electric lamp. Whether it is practicable to construct such a lamp it is not now within our province to consider. But as a partial application of the principles, it may be noted that of two fibres of equal resistance, the one short and thin, the other long and thick, the former, possessing a smaller mass and surface than the latter, is to be preferred.

* In writing this we are not unmindful of the difference of resistance produced in our imaginary fibres by the difference in their final temperatures, but the matter has no bearing upon the considerations here advanced, and we think it needless, therefore, to encumber our reasoning by attention to it.

EASTERN ELECTRICAL LIGHT AND POWER COMPANY.—The report of the Eastern Electric Light and Power Company to the 30th June last states that contracts have been entered into with the municipal authorities of Bombay, Broach, and Surat for street lighting with arc lamps. An engineer and staff have executed the works of these contracts, but, owing to the distance and the necessary time occupied in the transport of materials, no revenue from them is brought into the present accounts. In view of the re-establishment of order in Egypt the directors are giving attention to this field of operations, which they believe to be one of great extent. In Malta a temporary contract has been entered into with the Government for lighting the Strada Reale at Valetta. With respect to storage batteries the report states that the arrangement made with the Indian and Oriental Electrical Storage and Works Company has secured the right to use throughout the whole field of the company's operations accumulators constructed under the Faure and Sellon-Volckmar patents, and that large quantities of batteries and incandescent lighting appliances are being shipped to the East. The directors are assured that the success of this system of lighting must be "rapid and continuous." The following telegram has been received from the managing director: "Broach and Surat contracts resumed. We started lighting, and it has been a complete success. Orders received for lighting Viceroy's, Lieutenant-Governor's, Punjab chiefs' camps with fifty lamps."

EASTERN EXTENSION TELEGRAPH COMPANY.—According to the report of the Eastern Extension Telegraph Company (Limited) for the half year ending June 30 last, the gross receipts were £207,119 6s. 3d., against £191,580 19s. 8d. for the corresponding period; the expenses, including repairs, to £50,355 11s. 5d., against £54,098 8s. 8d.; and the net profits, after allowing for interest and sinking funds, to £113,393 3s. 10d., against £94,755 10s. 10d. The directors have charged £30,000, balance of cost of the new Singapore-Batavia cable, and have paid two quarterly interim dividends of 1¼ per cent. each, together with a bonus of 1s. per share, making 3 per cent. for the half year, and leaving £23,468 3s. 10d. to be carried forward.

INDO-EUROPEAN TELEGRAPH COMPANY.—The directors of this company have declared an interim dividend for the half year ending 30th June at the rate of 5 per cent. per annum, free of income-tax, payable on and after the 1st November. Coupons held in this country must be deposited at the company's London bankers, Messrs. Barclay, Bevan, Tritton, Twells, and Co., No. 54, Lombard-street, E.C., three clear days before payment.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.—This company announces a distribution at the rate of 1s. 2d. per £5 Second Bonus Trust Certificate on November 1, and payable two clear days after presentation of Coupon No. 15 at Messrs. Barclay, Bevan, and Co.'s Bank, 54, Lombard-street.

DIRECT UNITED STATES CABLE COMPANY.—The directors of this company have resolved upon the payment of an interim dividend of 5s. per share, being at the rate of 5 per cent. per annum for the quarter ended 30th September, 1882, such dividend to be payable on and after the 16th November next.

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THE BOROUGHS AND THE ELECTRIC LIGHTING ACT.

Not long ago we offered our condolences to the much-vexed and harassed members of certain local boards who were then being threatened by enterprising companies holding over them the terrors of the Electric Lighting Act if they did not at once receive the electric light with open arms. Since then, it would appear, these importunate terrorists have commenced active operations, and—as one well-informed authority asserts—have actually served notices on every local board in the kingdom. Moreover, from the manner of their procedure it would seem that they demand to be received not only with open arms, but with closed eyes. Every one of the applicants, if, indeed, they can be described by that inoffensive title, appears to imagine he has a right to say, If you don't adopt the new illuminant on your own account, you will be compelled to adopt it on mine. In other words, the local board is to have no alternative and no choice between adopting some other system without a moment's delay, or accepting the particular one—good, bad, or indifferent—which some petty local company may be prepared to offer.

Now, many as are the sins, real or supposed, of the Act in question, it cannot be charged with sanctioning such a state of affairs as this. If it did, then either its provisions must be the subject of immediate amendment, or else the fate of electric lighting is sealed. It would not be possible to enforce regulations so manifestly unreasonable and ruinous as those upon which many of the companies here alluded to base their pretensions. As a matter of fact, if the local boards are wise and firm it will not be possible to force their hands ; but they are not always firm, and not many of them are wise. Our fear is, therefore, that in many instances the work of making the first and crucial experiments in numerous instances will be entrusted to persons by no means competent to carry them out. The Act itself has been called premature by its enemies; its best friends are anxious that the action taken upon it should not be premature.

For one thing, the installations may be undertaken by companies which, to say nothing of their technical competency, may lack the needful capital to plan and carry out the task in an efficient manner, or on a scale that is likely to be remunerative. Of capital in the aggregate there certainly is no lack ; but the process of selling concessions has resulted in the creation of a host of little companies, whose only chance of success would be in securing all classes within their prescribed district as their customers—which is a very remote contingency at present—and who are not masters of a commensurate amount of capital even if they did secure them.

Further, the unnatural sub-division which recent speculation has brought about among the undertakers—this being now their legal designation—has most probably reduced the available scientific force at their disposal to a very attenuated condition. There are reasonable grounds for apprehension that in very many instances the subsidiary companies could not do the work properly even if they had it to do. The consequence of their attempting it would be that the trial would be a failure; they would not be allowed to extend or repeat it ; the proprietors would lose their money ; and, what is far worse, in our judgment, the electric light itself would be discredited. This is what has already happened, it may be feared, in one conspicuous instance ; and we see the use that is now being made of the failure—a failure which a very cursory examination would show to be due simply and solely to bad management or bad faith, probably to a little of both.

Now, it seems to us that there is at least one safeguard the local authorities who contemplate an agreement with any of the competing companies should stringently insist upon, and this is, that the plans, with all their details, mechanical, electrical, and engineering, should be submitted to the opinion of competent experts before the bargain is struck. This would ensure care in the planning, and presumably excellent workmanship as well. This is always done in cases where new buildings or works of any great magnitude are projected ; and a security which has been found to be needful for professional work of such old standing as those we have named is surely of equal necessity where electric light engineering—a quite new profession, one may say—is concerned. We are conscious that the effect of our advice tends to favour the big companies, because the big companies alone have competent electrical engineers and workmen in their employ. We say the big companies alone, and this is literally true ; but not all even of the biggest possess this advantage, as has been made manifest by many a ludicrous blunder which

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nobody but novices would have committed. This being the case, the competency of any small concern is a point upon which the local authorities are entitled to be satisfied, and we are confident that the Local Government Board would support them in their contention.

There is one other condition under which the smaller companies will work at a disadvantage. Many of the towns applied to may follow the example set them by Birmingham, declining to introduce the new light themselves, but placing no (ostensible) obstacle in the way of any company that likes to make the venture. In a town even of moderate size an installation on any considerable scale means a large initial outlay, and ability to wait the growth of business until it shall become remunerative. This is what no small company could afford to do. The prize is for those who can wait as well as work; and only the independent, well-endowed, and thoroughly experienced undertakings are at all likely to gain it in the experimental era of electric lighting. By and by the smaller bantlings will have their turn, and even now, if they are well managed, and do their work conscientiously, there is something for them to earn; but, on the whole, it is much to be regretted that so many candidates are in the field seeking public favour without either their means or ability entitling them to it. We say nothing of the fact that the concessionaire companies are at the outset saddled with the price of their concessions—a burden as heavy as speculation could anyhow make it. This is a question affecting their dividends, with which we have at present no concern whatever. What we prefer to see is the electric light promoted by substantial and competent people, who will do a legitimate business in a thoroughly workmanlike way.

GORDON'S DYNAMO ELECTRIC MACHINE.

The largest dynamo in existence has been successfully constructed at the Telegraph Construction and Maintenance Works at Greenwich, from the designs and under the superintendence of Mr. J. E. H. Gordon. This gentleman, well known in scientific circles as the author of a treatise on "Electricity and Magnetism," was, we believe, one of the late Clerk Maxwell's favourite students. He has during the past two or three years thrown his energies and knowledge into the construction of large dynamos. Professor Perry was, perhaps, one of the first to thoroughly study the economics of electric currents when generated by large machines of a type then quite novel. Mr. Edison was the first to construct large machines for supplying the current to a thousand or fifteen hundred of his incandescent lamps, but Mr. Gordon has gone far beyond Edison, and has constructed a machine for from five to seven thousand lamps—lamps, too, of a higher candle-power, and requiring a larger current than those of Edison. Hitherto the competition between gas and electricity has been of a most empirical nature, the electric current being usually supplied by small machines. We have from the commencement of the practical introduction of electric lighting strongly advocated the use of large machines. Mr. Gordon thinks that to supply a town with electric light a dynamo should be made to give as many lights as the town gas works. This is taking a rather higher view than we should advocate, and we imagine it would, in most cases, be a practical impossibility. The electric light to be successful must be as certain as gas. No machine has yet been constructed that has not given way somewhere at some unexpected moment, and if the whole lights of a town depended upon one machine they would be liable to be put out at any moment. The plans, therefore, for the supply of 10,000 lights should consist not of one machine with a capacity of 12,000 lights, but of at least two machines of, say, 7,000 light capacity each, and so in other cases.

The machine we illustrate and describe has been constructed of a size capable of giving a current to from 5,000 to 7,000 Swan lamps of 20 candle-power each, and the design is such that the construction of much larger sizes is a matter presenting few difficulties.

We have recently, in referring to certain articles and letters, indicated that in our opinion no correct estimate could be formed of the capabilities of a large machine from the results obtained from a small model. In designing a large machine special patterns are required. Weights and strains that may be neglected in the smaller machine are by no means so easily neglected in the larger apparatus. In a small machine such metal other than the conducting wire used in the armature can without unduly weakening the armature be so disposed as not to do mischief, either electrically or mechanically. But any machine, whether electrical or otherwise, which has to absorb 600, 1,000, or 20,000 horse-power, must have great strength and rigidity in its revolving parts. In fact, the whole framework of the revolving portion of such a machine must be massively constructed of wrought iron or steel, or some material equivalent to these. Those readers who know anything of the designing of machinery will be able to understand without further illustration the difficulties to be encountered in obtaining the necessary strength in the armature of a machine in which this portion revolves, and no metal except the conductor is to be allowed to move through the magnetic field, as is the case in one of the more recently-patented machines. In the Gordon machine the magnets revolve and the armature coils are fixed, thus allowing the revolving part to be built up of massive wrought-iron plates. This arrangement, too, overcomes another difficulty, as neither commutator nor brushes

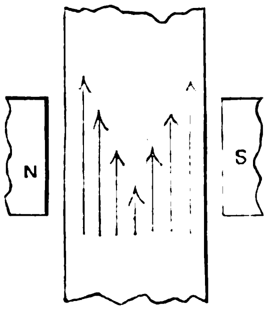

Fig. 1.

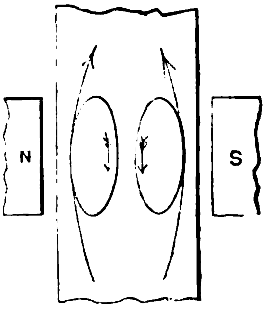

Fig. 2.

are used. We have all seen the loss by sparking at the commutators, and know something of the difficulties encountered in constructing a suitable rubbing contact for currents of from 1,000 to 10,000 or more amperes.

Another difference in the pattern of large and small dynamos is found in the fact that about the same E.M.F. is required when the work to be done is of a similar nature, whether the dynamo be large or small. The armature of a small dynamo is usually wound with a comparatively great length of fine wire. The exceptional cases are few. The conductor on the armature of a large machine must be much shorter and of much greater section. In the machine about to be described the conductor is about 170ft. long, and has a cross-section of 3·44 square inches. Such short, thick conductors may be constructed in two ways.

(1) They may be made of copper rod or ribbon.

(2) They may consist of a great number of separate coils of wire of moderate diameter, all connected "in quantity."

The latter plan has been adopted in the Gordon machine, where there are 128 coils, each wound with about 170 feet of No. 7 wire, and all connected "in quantity."

The use of a rod or ribbon has been much recommended by theorists, but we are not aware that it has been tried on a large scale. A long time ago, when discussing with Mr. Gordon questions relating to his machine, we expressed a leaning towards a ribbon, and Mr. Gordon informs us that about a year ago he made certain experiments to test its value. The results of these experiments have never previously been referred to in any publication. The failure was complete but at the same time instructive. Mr. Gordon says the effect of using a ribbon, of such a width that the

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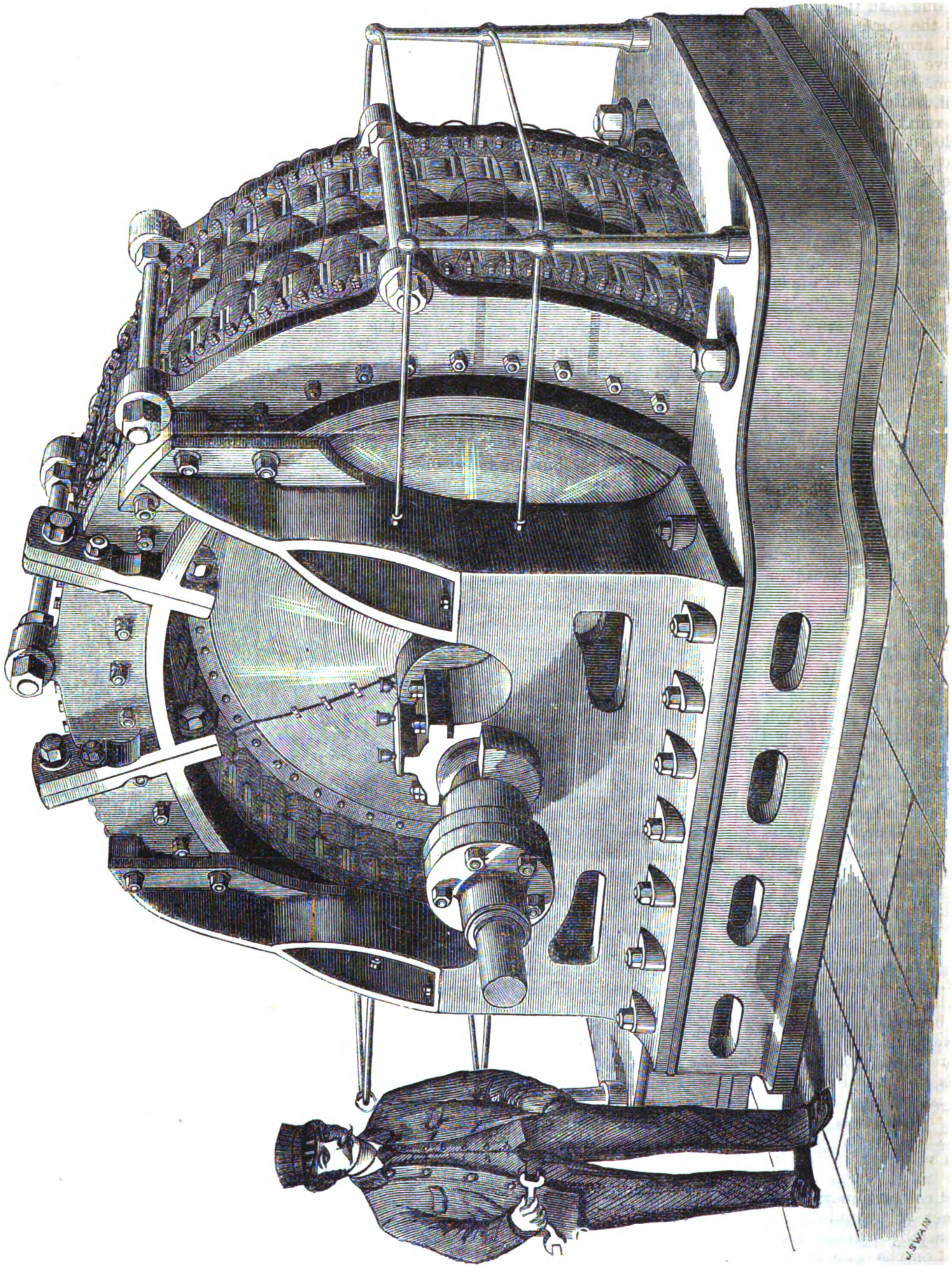
portion of its diameter which is furthest from the magnet poles is in a field of sensibly less intensity than the portion near to them, was that only a very small E.M.F. was produced at the ends of the ribbon, an enormous quantity of horse-power was absorbed, and in two or three minutes clouds of smoke poured out of the machine, owing to the burning of the insulator.

The reason of this is easily understood by looking at Figs. 1 and 2, which represent a ribbon or rod of copper passing between magnet poles, the direction of motion being supposed perpendicular to the plane of the paper. In Fig. 1 the directions and lengths of the arrows represent respectively the directions and magnitudes of the electromotive forces produced, while Fig. 2 shows the direction of the currents due to them. Thus we see that only a small portion of the current arrives at the ends of the ribbon, and



Side View of Gordon's New Dynamo Electric Machine.

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that most of it is wasted in forming "eddies" in the thickness of the copper.

In small machines those eddies are not serious, but they are, we should say, fatal to the use of copper ribbon in large ones.

Mr. Gordon's present machine is an improvement upon an earlier one. In the former machine the revolving rings each carried the same number of magnet coils as the fixed rings carried armature coils, and it was found that an injurious inductive action militated against the efficiency of the machine. If a certain number of lamps were maintained by one coil, and the circuit of the next coil was then closed, there was a reduction of light in the lamps of the first circuit by some 20 or 30 per cent. The cause of this was in the current circulating in opposite directions in the contiguous coils. In the present machine the armature coils are twice the number of the magnet coils, hence the magnets act on alternate coils alternately. For example, at the instant when the 32 magnets are acting with their maximum effect on the alternate coils 1, 3, 5 . . . . 63, the other alternate coils, 2, 4, 6 . . . . 64, are practically idle, and although the coils 1, 3, 5, &c., do act upon each other, it is with far less effect, owing to the comparatively long distance between them, rendering the effect inappreciable. On page 566 we give a general view of the machine, as seen at Greenwich, which will give a better idea of the machine than mere description. Its total weight is about 18 tons. The weight of the revolving magnet wheel is 7 tons. The space occupied by the sole plate is 13ft. 4in. by 7ft., whilst the diameter of the magnet wheel is 8ft. 9in. With 1,300 Swan lamps arranged 2 in series, the 128 coils are arranged 4 in series and 32 in quantity. The number of revolutions is 140 per minute, which gives a velocity of a little over 60ft. per second to the centres of the magnets on the revolving wheel. The revolving magnet coils are magnetised by the current from two Bürgin machines (one would, in reality, suffice), conveyed in the usual way by brushes making contact with the rings L, Figs. 3 and 4 on the collars C. The rings are usually of phosphor bronze, and are separated from the iron collars by an insulator. The resistance of the Swan 20 candle-power lamps is about 32 ohms hot, requiring a current of 1·4 ampere, and hence an E.M.F. of 45 volts. With 1,300 lamps the current in the magnets is 19 amperes, giving an E.M.F. of 88 volts. The current in each armature wire is $27\frac{1}{2}$ amperes. A detail illustration of the armature coils is shown in Fig. 6. Each coil is wound with wire ·185in. diameter, its cross section is ·0269 square inch, and the total cross section of the 128 coils of wire in quantity is $·0269 \times 128 = 3·44$ square inches.

The coils may be coupled up in almost any way desired. For example, if 5,000 lamps were placed on this machine, the 128 coils would be all coupled together for quantity. The number of revolutions would be raised to 180, a current of from 40 to 50 amperes would be used in the magnet coils, and lamps requiring 60 volts and 1 ampere each would be arranged all in quantity. This would give a current of 40 amperes in the armature wire, the E.M.F. being reduced to 60 volts. The armature wire will take a current of 40 amperes easily. The core in the coil N, is of wedge shape, and made of a sheet of boiler plate bent upon itself so that the angle forms the thin end of the wedge, and the free edges which do not quite meet form the thick end. A wedge shaped head of a T piece is inserted into one end of the folded plate and welded to it, the stem of the T being turned and screwed is passed through a hole in the fixed ring, and secured by nuts. A German silver flange is riveted on a shoulder cut on the end of the core. This flange has cut into it slots as nearly as possible in a direction at right angles to the currents which may be induced in it. The connection of the outer ends of the cores of the coils is made by prolonging the cores outwards from the magnet coil, and securing them to a fixed iron ring-shaped plate, which form their support.

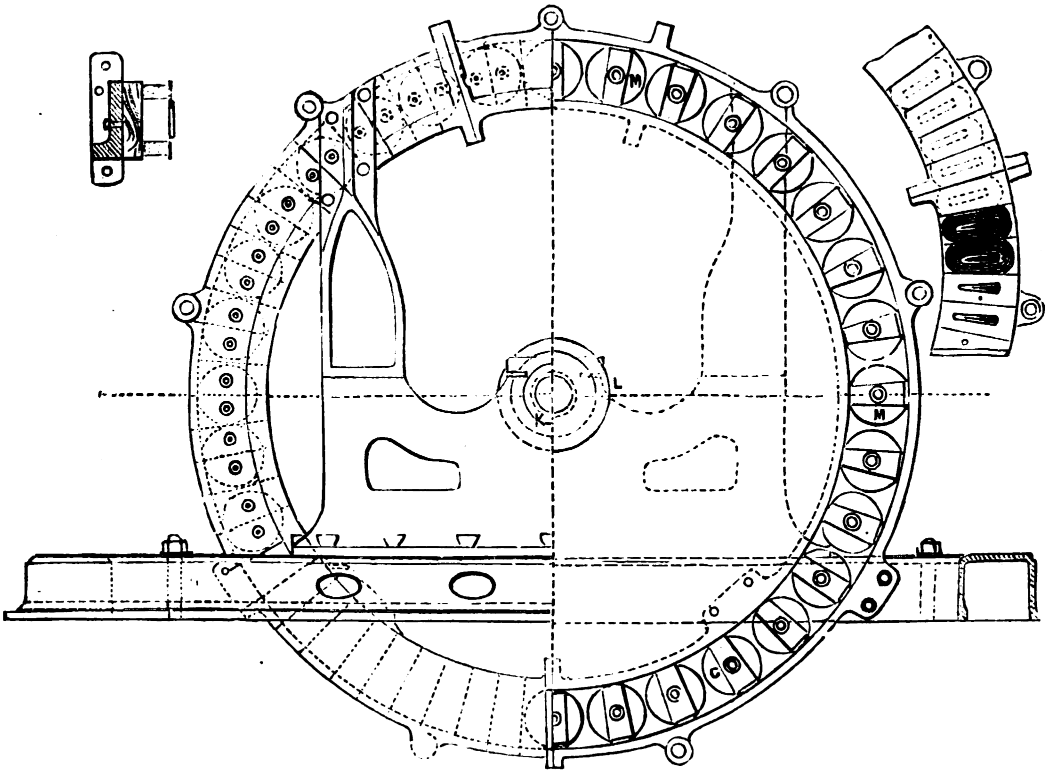

FIG. 3.– Gordon's Dynamo: Side Elevation.

In order that power may not be wasted in inducing currents in this plate, it is set back some distance, the cores being correspondingly prolonged. The space between the wire of the coils and the iron plate may be filled up with wooden plates or blocks, which form the second flange of the coil (v. detail in Fig. 3). The thickness is such that the algebraic sum of the magnetic potentials, induced by the magnet poles at any point of the fixed iron ring, is as nearly as possible zero.

The wheel consists of two central discs, A, and of two cones, B, whose bases fit upon the central discs, and through whose apices the main shaft passes. Discs A and cones B (Fig. 4) are made of segmental pieces of boiler plate, so cut that the grain of the plate is radial to the wheel at the centre of each segment. The segments are riveted together with butt strips

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in the way usual in boiler making. The discs A are kept apart at the centre by a cast-iron distance piece. At the rim they are kept apart by a wrought-iron ring. The cones B are of less diameter than the discs, so as to leave a space of flat disc all round exterior to the cones. The cones and disc are separated at the centre by massive cast-iron bosses,

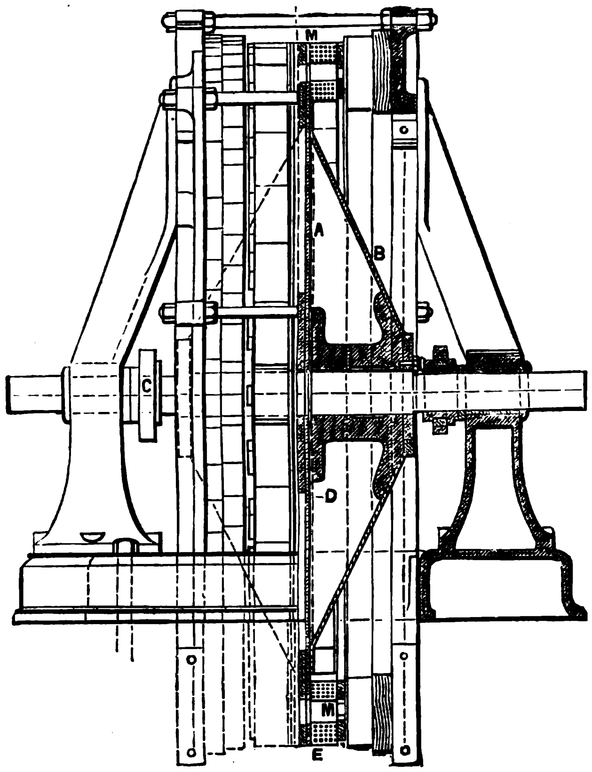

FIG. 4.—Gordon's Dynamo: End Elevation.

turned square to the shaft where they butt against the disc, and conical where they butt against the cones. The cast-iron distance piece D is of somewhat larger diameter than the bosses, so that the discs can be riveted to it without the heads of the rivets interfering with the bosses. The cones, discs, ring distance piece, and bosses are all

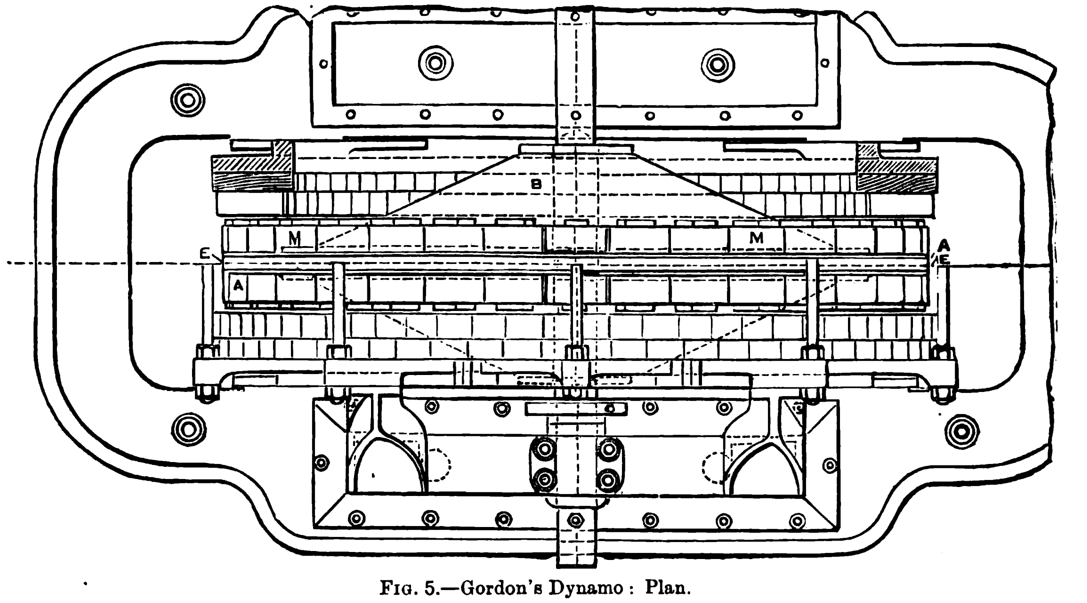

FIG. 5.—Gordon's Dynamo: Plan.

firmly riveted and bolted together, being still further strengthened by angle pieces placed between the disc and the cones. The discs are riveted with double butt strips, the cones with single ones. The butt strips of the cones are placed inside them, and the rivet heads countersunk, so that the outsides of the cones have perfectly smooth surfaces.

The flat outer portion of the wheel receives the magnet cores M, which, in the machine from which these drawings are taken, are 32 in number.

Each magnet consists of a cylindrical iron core, of two bobbins, of brass or other metal other than iron containing wire, and of two pole pieces. The core passes right through a hole in the discs A and wrought-iron ring E, and is fixed so as to project equally on both sides. The brass bobbins are then slipped on one at each side of the disc, and the pole plates being fixed on hold the bobbins in their places. The

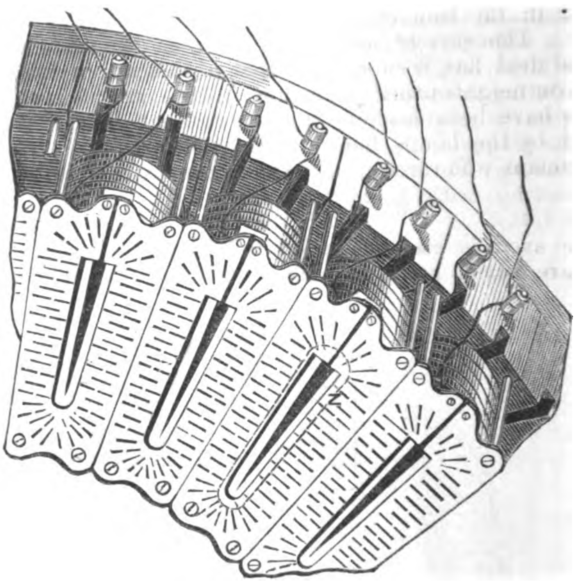

FIG. 6.—Detail of Coils.

pole plates are of iron, preferably wrought, their sides are not parallel, but form radii of the magnet wheel.

The shaft runs in bearings, preferably of phosphor bronze, which are carried by the side frames. There is a large gap or opening in the sole plate through which a portion of the wheel dips into a pit below the machine. This enables the centre of gravity to be kept low, and greatly increases the stability of the machine. The end thrust is taken by two loose iron collars placed on the shaft and pressed gently against the inside ends of the phosphor bronze journals by means of set screws projecting from the ends of the cast-iron bosses. These set screws are secured by lock nuts. Fixed rings of cast iron carry the fixed coils, each carries 64 armature coils. These rings are supported by being bolted to the inside of the gap in the sole plate, and by four cast-iron struts. They are also tied together by the screwed rods. Each fixed ring

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is made in three segments, one being much smaller than either of the other two. This is for the reason that if one of the magnet coils breaks down it can readily be got at by removing the small segment of one of the fixed rings and turning the wheel until the damaged coil comes opposite to the gap so produced in the ring. The damaged coil can thus quickly be removed and replaced by another.

The machine is coupled direct with the steam engine, so that no belting or complicated gearing is required; and by means of a water arrangement connected with the feed water of the boiler any local heating which takes place is concentrated in the iron frame and utilised in warming the feed water. The current, as we have said, is alternating, and as a good deal has been said about the influence of such currents on neighbouring telephone and telegraph wires experiments have been made by lighting the cable tanks and test rooms by the lamps, but no bad effect was found by the electricians who carried out the experiments.

Method of Regulating.

The exciters used to supply the current to the magnet coils are driven by a small separate steam engine. A dark room (Fig. 7) is provided near the machine, in which is a photometer, and through which the steam pipes of the two engines pass. Stop valves are attached to these tubes, so that a man can control them while reading the photometer. A slow motion is attached to the valve wheels, so as to avoid any sudden changes of light. The following instruments are placed in the photometer room, in convenient positions for observation:—A strophometer, for showing the speed of the large dynamo; an Ayrton's ammeter (Am. mt.), for showing the strength of the exciting current; a steam-pressure gauge (P. G.), &c.

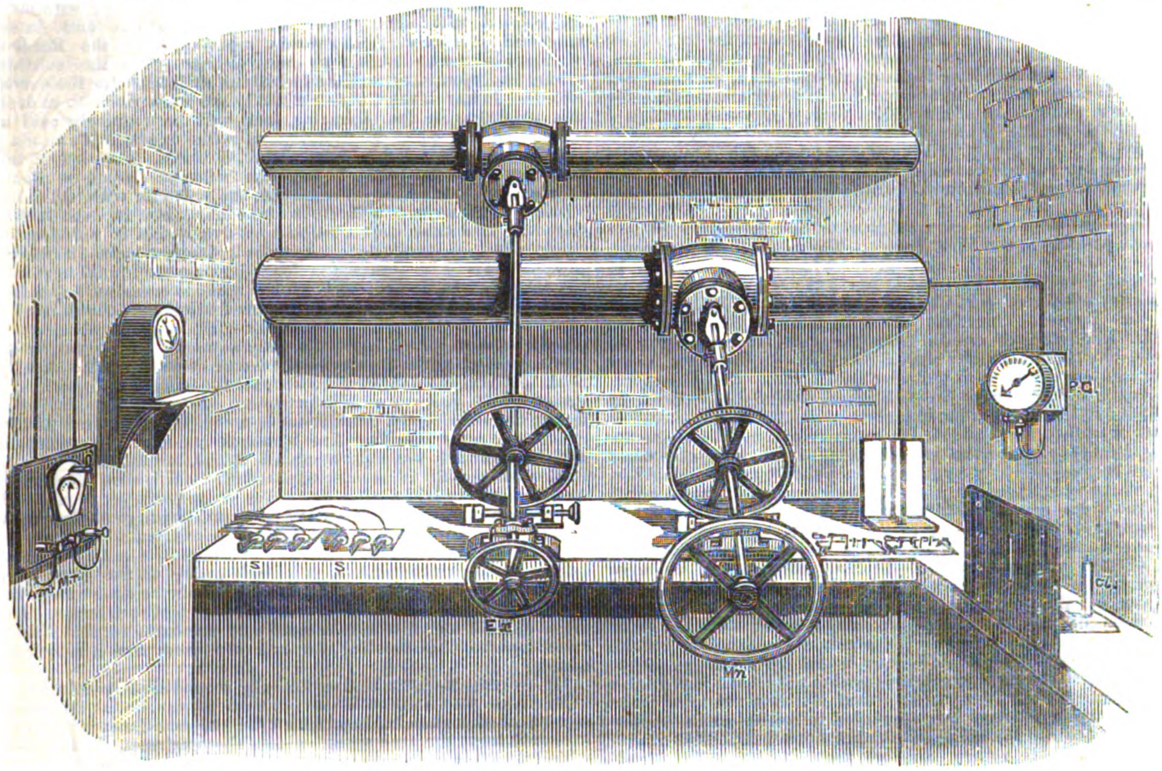

Fig. 7.—Dark Room, with Photometer, Ammeter, &c.

There are two lamps in the photometer, one in each of the two circuits into which the machine is divided. They are lighted alternately by switches.

If there is any very great difference in the number of lights on the two circuits, the one having the fewest lights will be brightest. In practice when the same class of houses are supplied from the two circuits there will never be any great difference in the number of lamps on each. An adjustment is, however, provided by the street lamps near the machine, which by a simple switch, S S, can be instantly transferred 50 or 100 at a time from the dimmer circuit to the brighter one.

Efficiency.

Daily indicator diagrams have been taken by the company's engineers and compared with electrical measurements made on the lamps by the company's electricians. The tests show that 94 per cent. of the power absorbed by the dynamo and exciters is reproduced in the lamps.

The machine we have thus briefly described was shown in action to a number of scientific gentlemen on Wednesday night. Among those present we noticed Sir James Anderson; Mr. Shuter, managing director of the Telegraph Construction and Maintenance Company; Mr. Clifford, the manager of the works, with his right hand man, Mr. Lucas; whilst electric light, &c., interests were represented by Mr. Swan, Mr. Sterne, Mr. Crompton, Mr. Moore, Mr. Willoughby Smith, Mr. P. F. Nursey, Mr. V. Pendred, Mr. W. W. Beaumont, Mr. J. Munro, Mr. Dever, Captain Halpin, Mr. William Smith, Mr. J. Fuller, as well as the inventor, Mr. J. E. H. Gordon, and others well able to form an opinion as to the merits of the machine, electrically and mechanically. The concensus of opinion was that Mr. Gordon had achieved a decided success—that he had provided *the* machine that was at the present moment required for the development of incandescent electric lighting.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.

The eleventh ordinary general meeting of this Company was held on the 25th inst. at the City Terminus Hotel, Cannon-street, under the presidency of Mr. C. W. Earle.

The Secretary (Mr. Constantine M. Hooper) read the notice convening the meeting, and the minutes of the last meeting, held on the 10th May. An abstract of the report has appeared in *The Electrician.*

The Chairman said: Gentlemen, the accounts which we present to you to-day, in as far as they relate to the ordinary and normal administrative expenses, contain nothing which is worthy of any special remark, and, therefore, I will not take up your time in referring to them in any detail. I may, however, mention that they are slightly less as far as current expenses are concerned than in the corresponding half year. On the other hand, the traffic receipts are the best we have ever had. They are very poor; compared to other companies of like magnitude they are excessively poor, but still it is a satisfaction to find that there is a little increase this half year. Turning from the ordinary expenses of administration to the repairing expenses, we come on a very disagreeable item indeed. The ordinary repairs I may say are about what we have been having of late years, but the very heavy expenditure on the St. Thomas-St. Kitt's cable has taken away your dividend, and is a very serious item. You may remember that a year ago we laid in some 65 knots of new cable in a deviation to the east end towards St. Kitts. At that part of that section we had had experience, from frequent

breaks, that the ground was very unsuited to a cable. We, therefore, examined and sounded the ground, and found a better line a little to the north, and we laid in 65 knots of new cable. We thought after that, as the west end of the section had not troubled us very much, that we should have pretty secure communications, but in the beginning of this year a break occurred in the west end. The ship went to grapple, and found the water excessively deep, the bottom very rocky, and a very uneven surface, falling many hundred fathoms. Perhaps with a mile of surface you had a difference of 500 fathoms of water. All that was very unsuitable to the life and duration of a cable. When the ship came to grapple for the cable it was found to be so embedded in the rocks in the ten years it had been there that it was impossible to do so in 1,700 fathoms of water. We grappled along the line for a considerable distance, were very much interrupted by bad weather, had constantly to run into St. Thomas's for shelter and coal, and operations were very much delayed in consequence. Altogether she was seven months at the work, but at last we thought it better not to waste any more time on that section of the cable, although we were naturally anxious to save as much as we could, and did not like prematurely to desert the hope of recovery. However, there was at last nothing for us but to lay in a new section, expending 106 knots of new cable, and eventually to join the cable up. This, I suppose, will cost us about £15,000 altogether. It is a very heavy cost, because our revenue is very poor, but it is trivial when compared with other companies. There is no other company which has not equal or much larger expenses on repairs, and I believe that Sir James Anderson and Mr. Weaver will tell you instances of as much as £90,000 spent in other companies in repairing a single cable. Although such an expenditure would be light in the case of a prosperous company with a good revenue, it is a very crushing blow to us to have such an expensive repair as this. The great point of interest this half year is the result of our mission to the West Indies and the conference held at Barbadoes; but before going to that I must ask you to allow me to go back a little in our history. Soon after the present board was elected in 1874, and we had a system for the first time in thorough operation, we found out during two years of almost uninterrupted working at every station that the traffic was very poor, and instead of £156,000 a year, which was mentioned in the prospectus as being the traffic of those regions, we really found it was nearer the £56,000 than the £156,000. Having made this disagreeable discovery, it became our duty to consider what was best to be done, and I remember somewhat being taken to task, I think by my friend Mr. Abbott, for saying that our only policy was a policy of importunity. I think the experience we have had since then has confirmed us in that opinion. There is no development possible in the West Indies. The traffic is so very poor, the colonies are so very small, and there is not traffic enough to support a system like this. Therefore, we have endeavoured from time to time to obtain a revision of the contracts under which the Company was formed. Our first effort in this direction was the despatch of Mr. Kingsford to obtain from the colonies permission to increase the rates, for the rates were made a condition in the Acts under which the Company was constituted and the cables laid. We, therefore, went to the colonies, and succeeded in getting a revision of the tariff in our favour. This revision has produced certain good effects. Our traffics have been better than before, although—we were obliged to concede something in asking for this power—the introduction of the word-rate when codes became more perfect has very much diminished what would otherwise have been an increase of our revenue by the increase of rates. After the increase of rates was granted and established, we still found that the revenue was unsatisfactory, and we therefore, two years ago, again decided upon appealing to the colonies for some further concessions and some revision of the very onerous conditions under which we were established, and with which, I may add, the present board had nothing whatever to do. We obtained the services of Mr. Grosvenor, who went out for some five or six months to the West Indies, and visited all the colonies. He obtained no tangible result, no accession of revenue from that visit, but he did obtain this—a conference on the subject of telegraphic communication with the West Indies was assented to, and after receiving the approval of the Secretary of State for the Colonies here the conference was appointed to be held at Barbadoes in May of the present year. Mr. Grosvenor could not return; his engagements did not admit of his return, and we requested Mr. Kingsford, accompanied by the secretary, to proceed to and be present at this conference. The conference assembled, Mr. Kingsford made a very able speech, and they proceeded to business; but it was very soon apparent that it was not to inquire into our position, or into what we were able to do, or what we ought to get, or what would be fair and liberal treatment of us, that these delegates had arrived there, but really to propound a scheme of their own, which is mentioned in the report. It is quite true that some of the smaller and one of the larger colonies were in favour of giving us what we asked for—an increase of subsidies; but two of the principal colonies were opposed to that, and came with their minds so made up to the scheme we have announced that they did not agree with the feeling of the smaller colonies, and the smaller colonies were helpless in the matter. The result has been the proposal of this scheme. The first resolution introducing this scheme, as a justification of it, is to the effect that the West India Telegraph Company has failed to satisfy the requirements of the West Indian colonies. Well, before we attribute very much to that statement I think it is only fair to ask whether the requirements are reasonable, and whether the Company was put by its revenue in a position to satisfy those requirements. There are two requirements which it appears to me the West Indian colonies insist upon. One is cheap rates. Well, the rates have been fixed by the colonies themselves. They are certainly high rates, but, of course, in poor regions like these, where the telegraph is very little used, you must have high rates. That is a tale that holds good in every part of the world. Where you get out of the beaten track, it does not matter whether it is a hansom cab or an omnibus, you must have a high rate if you ply in countries where there is not very much custom. The other requirement is a very expensive free trade bulletin, which is a matter that has always given us great trouble and annoyance. We are obliged, as I have often said before, to publish a great quantity of the market prices of the materials in which the West Indian colonists deal, and telegraph the movements of all the mail steamers, a list of their passengers, and the general news of the world. This is not only a very serious and difficult duty for a telegraph company to perform—for it is not a news agency—but it eats into a very important source of traffic. It is really like asking railway companies coming from the north to supply the metropolis with coals for nothing. It is really giving the materials on which we ought to live. Not only is it very disadvantageous to us in that respect, but it also causes the greatest discontent. No matter how this news supply is carried out, the colonies never seem satisfied. You can quite understand in that very dull part of the world a man gets up in the morning and calls for the newspaper, or whatever it is in which this free bulletin is printed, and finds, as is very often the case here, that there is no news. We, in England, after looking at *The Times*, even sometimes say there is no news. We are then told that we are not giving proper news. The English colonies complain that we send them nothing but French news, and the French colonies complain that we send them nothing but English news; and between the two we get into very bad odour all round, when it is not our fault. Well, these requirements are difficult to meet, and it does not seem to me that the conference took very much trouble to inquire whether they were reasonable requirements or whether we were in a position to fulfil them. However, the scheme as proposed was carried unanimously by the delegates. I do not myself believe very much that this scheme will come to anything. I do not think that our Government will be inclined—or that there is any precedent for it—to put £350,000 into such a scheme, and I should very much doubt whether the smaller colonies, when they come to understand the measure, will participate in it. Some of these colonies have a gross revenue of about £30,000—about the income of a good substantial English squire—and when you think of the heavy cost of repairs in the Atlantic—sometimes as much as £90,000 for one repair—I think the colonies will look a little more closely into the matter before going into it. As the matter stands, Mr. Kingsford is now visiting the different colonies, and I am not without hope that some good will come from his representations and interviews. I may tell you that I have this morning seen the Receiver-General of Trinidad, who authorises me to say that the subsidy of that colony has been increased, and is in the estimates for the current year at £6,000. It has hitherto been £2,500, and I am given to understand that this £6,000 is in the estimates, and will be regularly paid unless this scheme should come to anything, of a line between Bermuda and Nova Scotia, which I do not believe. That, I think, is a sign of more liberal treatment to us, and I am not without hope—on some concession on our part—that we may get the colonies with us. I think they will see that no one is likely to take our place in such a scheme, that they will find that a direct line to Nova Scotia is not practical, and I think when it has fallen through an improvement in colonial feeling towards us will be obtained. For that purpose Mr. Kingsford is now in the West Indies, and certainly on the present occasion I should deprecate much discussion on the point, because I think sometimes hard things are said which in the present critical condition of negotiations may turn people against us. I have the satisfaction of telling you that since the report was published repairs have been made in the cables, and we are thus again placed in communication with all the islands and stations except the Panama line, which is still interrupted. As to the Panama line, you have learnt from the report that there is a competing scheme laid, which will reduce our rates over that line by about one-half. I suppose our revenue will be reduced probably by about £1,500 or £2.000 a year. That is a matter which one is always exposed to in this sort of enterprise. The Americans have laid a cable down the West Coast of Mexico, touching at Panama, and joining with the West Coast Company's cable line at Lima. I think I have now said all that I have to tell you. We are not without hope, though we feel very much the unfortunate results of this enterprise, but we are convinced that it is entirely owing to the ground upon which we have to work, and that nothing further can be done except by an alteration of the terms originally entered into by the colonies. I now beg to move, "That the directors' report and accounts to the 30th June, 1882, submitted to this meeting, be and the same are hereby received and adopted."

Mr. WILLIAM FORD having formally seconded the resolution,

Mr. WILLIAM ABBOTT observed that he was not at all surprised at the silence of the shareholders, which he suspected was attributable to the extraordinary announcement, which the chairman had confirmed, and which they had seen in the report—that instead of the colonists of the West Indian islands rendering the Company assistance, they had in contemplation a magnificent scheme to connect the colonies with another colony to the north. The plea raised by the colonies when the Company had asked them for further assistance was their poverty; but if they were so poor, how was it that they had such enterprise as to find £650,000, contingent on the English Government giving them £350,000, to compete with English capital already lying dormant? He could scarcely conceive it possible how men in their senses would believe that such a thing would go down in England. As he had just returned from America he did not share in the surprise felt by the shareholders generally. The great effort of our colonies—he did not exclude Canada—was to get as much capital as they could out of Englishmen, and as soon as they got it to set to work to kill it for their own advantage. As long as he could speak and write he was determined to let the English public know that when the colonies protected themselves English capitalists must protect themselves. He hoped that the colonists would learn to-morrow morning by means of the company's lines—let it form part of the free news with which they were supplied—that not a single shilling of English money—either by way of Imperial or any other guarantee—should go from this country to compete with an English enterprise already established. The colonists did not say, What can we do for you to give us a better service? but that they wanted lower rates. The Company had no objection to give them lower rates if they would increase their subsidies, and there was no excuse for their not giving an increase of subsidies when they openly professed their ability to find £650,000 for a new scheme.

Mr. VEARES, speaking as an ordinary shareholder, held that the directors could not be blamed for the unfortunate position of affairs, nor could they find fault with the consequences arising out of the natural difficulties against which they had to contend. It was, however, a hard matter for them when they found the colonists turned against them. In fact those gentlemen must believe in human depravity. They could have no milk of human kindness in them. How could they ask for such concessions as they did from the Company, and yet refuse to give them any help? He, however, thought there was some encouragement to be found in what had

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been stated in the report, and he could only hope that there was some sunshine before them.

The CHAIRMAN then put the motion, and it was carried unanimously.

Mr. ABBOTT, in moving a vote of thanks to the chairman and directors, inquired whether it would not be better to devise some scheme by which, instead of paying such large sums of money out of revenue on worthless cables, they could have a thoroughly efficient cable.

The motion having been seconded,

The CHAIRMAN, in reply, stated that the time was coming when they must consider such a scheme, but it was a difficult thing to fix a time when they were to abandon their property.

Mr. ABBOTT: It must be done in conjunction with the colonies.

The CHAIRMAN assented, but added that nothing could be done in the matter while the scheme referred to of the colonies was in the air.

The proceedings then terminated.

WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).

The fifth ordinary general meeting of this Company was held on the 23rd inst. at the City Terminus Hotel, Cannon-street, under the presidency of Mr. Robinson Kendal.

The SECRETARY (Mr. Fred L. Robinson) having read the notice convening the meeting, the report of the directors, which has appeared in *The Electrician*, was taken as read.

The CHAIRMAN said: Gentlemen, in rising to move the adoption of the report, and to say a few words in regard to it, I have, in the first instance, to say why it is issued at so comparatively late a period. You all know that a state of war, and a state of semi, if not actual censorship, exists on the coast, and that it is impossible in the present disorganised state of the postal and other arrangements of the country to count upon anything like regularity in the transmission of accounts and correspondence. As a matter of fact, copies of some of our Lima accounts were either lost or intercepted in transmission to this country, and it often happens that letters come to hand two or three mails behind time, other letters written weeks after arriving before them. This, I need not say, is a serious matter, when some three months are taken to send out an inquiry and receive an answer by post; and hence it is that our accounts are issued so late in the year. Next year we hope we shall not only have a better and more promising balance-sheet, but we hope to issue it at an earlier date. As regards the report itself, I may say that although it is not so favourable as the board could wish, it is yet as satisfactory as under all the known circumstances we could reasonably expect it to be. Whilst reducing our expenditure we have increased our income by a sum of £15,000 for the year, and we show a net profit of £1,308, a result which, as the report says, may be looked upon as satisfactory, regard being had to the continuance of this deplorable war, and considering that Lima, one of our terminal stations, was only open for traffic for half the year, whilst Mollendo, another of the Company's stations, was blockaded by the Chilian fleet during the whole of the year. Our staff upon the coast we increased last year by two clerks, and this month we are sending out two more clerks, in anticipation of an increase of traffic and of work; but, notwithstanding this increase in our expenditure, I have reason to think that our expenditure as a whole will be less than at present, for there are some items in our expenditure to which I need not now call attention which will be reduced, and others which will disappear altogether. As it is, and as the report says, we have this year paid all the interest on our debentures, as well as the item £8,299 15s. 8d., "Outstandings due by the Company," and we have now a respectable balance at our banker's. As regards the future of the Company, I may say, though it is the business of the board to administer the affairs of the Company, and not to indulge in predictions or expectations, that without counting upon the possibility of peace being restored we hope we shall have a sensible addition to our present net income, and that from our own work—to say nothing of our connection with the new and extensive lines touching at the Central American Republics and running away along the Pacific for some 3,000 miles until they reach Mexico and the United States—we shall be able to show in our next report what the present report foreshadows—a considerable improvement in the position and prospects of the Company. The guano contract was let, I believe, for one million tons during the past week, and the shipment of this guano must bring necessarily an increased business to the coast. But, as a matter of fact, and speaking broadly, it is not a guano contract that is wanted on the coast, but peace—peace between Chili and Peru and Bolivia. The other day there was opened at Taltal another of those small lines of railway which run inland from the coast as they run inland from no other coast; and from this, under anything like a settled state of things, something in the way of increased trade may be expected. But it is not to systems of steam locomotion or steam navigation that we must ultimately look, good as both undoubtedly are, but to a restoration of peace and the general re-establishment of something like credit, commerce, and industry. As a trading company—for we are neither more nor less—it is not our province to interfere with political questions, but it is rather our province to be the friends of all and the partisans of none. Still, it can never be out of place to regret that it has not been possible to bring this terrible and bitterly hostile war to a peaceful if not happy issue. We all know the social and trading condition of Lima, or if we do not know it, it is easily summed up in this, that the rate of exchange is 2½d. a dollar! What the rate of exchange is, so is the state of trade, and what the state of trade is we all know. We can, however, only hope for better days and better things, and nothing would give me greater pleasure than to be able to announce to-day that peace had been concluded between Chili and Peru and Bolivia. As regards this Company's claim, I must ask you to be good enough to leave its settlement in the hands of the board. It involves complex questions of municipal and international law, as well as questions of right and justice; and this, as you can readily believe, is not the place to discuss all these. Of this, however, you may rest assured that the board will not cease to press this claim, which they believe to be both fair and just; and unless the Chilian Government is in our case to belie its high reputation for honesty and honour, we ought not to press it in vain. I beg to move the adoption of the report and accounts.

Mr. THOMAS FIELDEN CAMPBELL having seconded the resolution,

The CHAIRMAN put it, no shareholder rising to ask questions or to address the meeting, and declared it carried unanimously.

On the motion of Mr. CAMPBELL, seconded by Mr. W. E. MACANDREW, the retiring directors—Messrs. Robinson Kendal and Matthew Gray—were re-elected.

The CHAIRMAN returned thanks for his re-election, and observed that the Board had worked very harmoniously and assiduously in the interests of the Company. He did not wish to praise their efforts, but he was sure that nothing they could have done to promote the welfare of the Company had been neglected. There were hopeful signs about the Company, and they need not despair, but the results must speak for themselves.

Mr. GRAY also acknowledged his re-election, and assured them that he would do all he possibly could to promote the interests of the Company.

On the motion of Mr. MASON, seconded by Captain MARSHALL, Mr. J. Weise (of the firm of Turquand, Youngs, and Co.) was re-elected the auditor of the Company.

Mr. MASON then moved a vote of thanks to the chairman and directors for the manner in which they had taken care of the interests of the Company. He considered that the accounts were very satisfactory in every way, and that it only required a glance at them to show what a great deal of care, attention, and trouble the board must have given to their interests, when they saw such a large increase of traffic with such a decrease as there had been in the expenditure. He thought they might consider the Company most carefully managed, and he hoped when they met again they might have some reason to congratulate themselves on the result of the working with the new lines to America. The new means of communication, he had no doubt, would create new causes for it, and he thought they might expect the new lines to be made good use of. He hoped that the chairman's prognostications would be more than realised.

Mr. JOHN TAYLOR seconded the motion, and it was carried unanimously.

The CHAIRMAN, in returning thanks, reminded them that on the last occasion they had among them Colonel Tilney—an old and esteemed friend of his, who was since deceased. He should never forget that, in talking to him towards his end, Colonel Tilney spoke of this Company, and expressed his confidence in the directors, telling him at the same time that he had left a testamentary injunction that his shares in this concern were not to be sold, but were to be kept for the benefit of his family. He held that as a measure of Colonel Tilney's confidence. The directors would do all they could as trustees—which all directors were—not only for Colonel Tilney's family, but also for the shareholders generally.

The proceedings then terminated.

THE ELECTRIC LIGHT IN BIRMINGHAM.

REPORT OF THE GAS COMMITTEE.

The following is the report of the Gas Committee to be presented to a special meeting of the Town Council, on the 31st inst.:—

The committee report that they have given their most careful attention to the important subject referred to them by minute of Council 12,878. They have had the advantage in their consideration of the subject of having before them a clear summary of the Electric Lighting Act, with explanatory notes, prepared by the town clerk, a copy of which is submitted with this report to each member of the Council.

They report that they are of opinion that the experiment of supplying electricity from a common centre, if tried in Birmingham, should be conducted under the most favourable circumstances, and that every facility should be afforded for it that is consistent with the public convenience, welfare, and safety. They do not think that the interests of the gas supply, as the principal lighting agent, are threatened by the proposed new illuminant. If these interests were so threatened, the committee, while they would recognise the seriousness of the position, believe that it would be their duty, on the one hand, to consider the question of electric supply and to promote the supply, with a sole regard to the general convenience of the inhabitants of the town; and, on the other, to continue to develop in every possible way the new fields for the employment of gas which are every day presenting themselves, and to persevere boldly in any expenditure that will cheapen its production. The committee believe that, so far as present knowledge goes, the advantages to be gained by the trial in Birmingham of the experiment of distributing electricity will not compensate for the loss and inconvenience which must follow the breaking up of the streets for this purpose in the busiest parts of the town. They are of opinion that the experimental stages of laying conductors of electricity and branches therefrom will necessarily be productive of much greater inconvenience than that occasioned by the established gas and water supplies, and that it is a misfortune that, if the experiment is tried at all, this inconvenience must occur in the localities where trade is busiest. Against these considerations, however, must be placed the apparent necessity that the success or failure of the new system must be proved in each town. This is shown by the attention which has been directed to the recent successful display of electric lighting in the Town Hall. The Swan incandescent lamp, which was used on that occasion, was employed last year, on a large scale, to light the principal exhibition rooms of the Royal Academy, but the experiment has been discontinued, and the former system of gas lighting resumed. So far as the lighting of the rooms is concerned the success was apparent in both instances, but the difficulty which has stopped the adoption of the new system at Burlington House is not known here, and it, consequently, appears to be necessary that experiments should be made from which conclusions can be drawn for local guidance. It must also be remembered that it is desirable to place the supply of electricity, as early as possible, under Parliamentary control. Overhead wires for private supplies, which are known to be a source of public danger, are already being fixed in Birmingham, and it appears to the committee that this is a matter which should receive the early attention of the Council. Further, the new system, if successful, will be of immense importance to those manufactures in which Birmingham and the district is particularly interested, and, for this reason alone, the town will, probably, be anxious that facilities should be afforded for the experiment, provided that the inconveniences attending it can be minimised to the fullest possible extent. Having regard

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to these considerations, your committee have come to the conclusion that it is not desirable to oppose the experimental distribution of electricity from a common centre in Birmingham. This being so, they are of opinion that the experiment should be on a sufficient scale to ensure a thorough trial of the system, but should probably be limited at this early stage to one or two areas. They have, therefore, considered whether this supply should be undertaken by the Council, or whether consent should be given to one or more of the applications for power to supply of which notice has been given by electric lighting companies. They think it desirable to place fully before the Council the reasons which have chiefly influenced them in the recommendations which they make in this report. They remind the Council that when the gas undertaking was acquired for the town its purchase was advocated for the following reasons:—

(a) That monopolies in any way sustained by the State should be in the hands of the representatives of the people.

(b) That the Council ought to have under its own control the right of breaking up the streets within its jurisdiction.

(c) That considerable profits would be made by the municipality by savings in the rate of interest paid on capital, and in other ways, over and above the profits possible to be made by companies, and that these profits could legitimately, and without injustice to consumers, be applied to decreasing the burdens of the town.

(d) That while the Council would largely add to its responsibilities by the acquirement of the undertaking, there were no onerous obligations attached to the carrying on of the work.

(e) That gas had become, though not in the same degree as the supply of water, a public necessity.

The committee have inquired whether or how far these motives are applicable to the proposal that the Corporation should undertake the supply of electricity, and they submit the following considerations to the attention of the Council:—

a. As to Monopolies.—The Electric Lighting Act has been passed with the especial view of preventing the establishment of a monopoly. More than one undertaking may be authorised in the same area; and it should not be overlooked that if the system proves successful in a limited area, the Corporation may apply for powers to supply in such area, or in the remainder of the borough.

A license can only be granted with the consent of the local authority, and for seven years. It cannot be renewed without the consent of the local authority. A provisional order granted to a private company may be terminated by purchase of the electric plant on favourable terms by the Local Authority at the end of 21 years and six months' notice, or such shorter terms as Parliament may impose, or as may be arranged by agreement.

b. As to the Control of the Streets.—A license or provisional order may contain any provisions and restrictions which the Board of Trade thinks expedient, to enable the local authority to exercise any of the powers of the undertakers with respect to the breaking up of the streets repairable by the local authority. While the town clerk thinks that it is open to contention whether this section of the Act containing this provision gives the local authority power to insist on retaining this right, he is of opinion, having regard to the general purport of the Act, that the Board of Trade has the power to make provision in the license or order that the local authority may control the breaking up of streets, may make contracts with an electric lighting company for the performance of this work, and themselves undertake the control and breaking up of the streets.

c. As to Profits on Undertaking.—There are no reliable data on which an estimate can be formed of the prospect of a profitable supply of electricity being undertaken. So far as it is known there has been no instance of a profit having been derived from such a supply, but it has been replied that this is a presumption only, as no electric company has yet separated in its accounts the profit and loss on manufacture and supply. It must not, however, be lost sight of that some at least of the scientific witnesses examined before the Parliamentary Committee on the Electric Lighting Bill believed that such a profit is attainable, while others—and those, perhaps, with the best practical acquaintance with the subject—were more cautious, and stated that this had to be proved by experiment on a sufficient scale. One of them (Mr. Crompton) stated that no remunerative return was to be expected during the first seven years, at least, of the experiment. Mr. Gainsford, a member of the Town Council of Sheffield, who has been using electric lighting in collieries with which he is connected, is reported to have said in a recent debate in the Council of that town that his experience had been that electricity cannot be provided at the price of gas even when the motive power is provided free.

The tenders obtained from electric lighting companies by the City of London and the abandonment of the large installations of incandescent lamps at the Royal Academy and at Stafford House, while significant, are not conclusive. It is urged by the representatives of the companies, and notably by Dr. Siemens, that if private lighting had been added to the public lighting undertaken in the City the immense discrepancy between the cost of electricity and gas would have disappeared. The systems of incandescent lighting referred to were self-contained, and nearly all the scientific witnesses examined on behalf of the electric companies when the Electric Lighting Bill was under examination were agreed that nothing but a large experiment from a common centre would determine the question of cost.

While it is undoubtedly a misfortune, under present circumstances, that no accurate information can be obtained on the capital outlay which will be required for such an experiment, it is, perhaps, possible to learn what the minimum cost of the chief apparatus would be. It was stated by Dr. Siemens, in the proceedings before the House of Commons Committee, that areas not too large for economical supply were required, and that in densely-populated towns a quarter of a square mile (880 yards square) would be a proper electric district. He roughly estimated the cost of plant for from 24,000 to 30,000 incandescent and 70 arc lamps in such an area at £100,000. Other witnesses submitted estimates as follow:—

Mr. Crompton, 50,000 incandescent lamps, per square mile ...	£200,000
Dr. Hopkinson, 50,000 incandescent lamps, per square mile ...	200,000
Mr. Johnson, 50,000 incandescent lamps, per square mile......	150,000 to 200,000

It is evident, however, that these estimates must, to a very large extent, be applied to the number of lamps, and not to the area selected. Taking the number of the lamps as the measure of the cost, they practically agree on a capital account of £4 per lamp. There is, however, some later information available. A statement of the comparative cost of dynamos has recently been published in a letter to *The Times*, from which it appears that the cheapest form of large dynamo yet made is the Siemens, which can be provided to supply 50,000 incandescent lamps at a cost £75,000. In this statement it was added that the cost of a recently-devised dynamo, the Ferranti, had not yet been ascertained, but that it would be less than that of any now in use. A subsequent statement in the *Daily News* gives the estimated cost of this machine at £1,200 for 2,000 lamps.

The prime cost of the conductor from Messrs. Winfield's works to the Town Hall, about 500 yards in length, is stated to have been more than £800. This is at the rate of about £3,000 a mile, without services, but it must be remembered that a larger and therefore more costly conductor would be required for the longer distances involved in an area of 880 square yards.

It has been stated by electricians that economy in supply can only be obtained by the use of large condensing engines of 500 horse-power, requiring a consumption of from 2lb. to 3lb. of coal per horse-power. The committee have, however, been informed by an eminent practical engineer, whose opinion is valuable, that engines of 300 indicated horse-power will be the most economical, the small saving in coal effected by the larger engines not being more than, if sufficient, to cover the interest on the additional proportionate cost of the larger engine and the increased cost of repairs. In addition to the outlay on this plant, there would also be the cost of land for central station (no inconsiderable item, when it is remembered that it must be in the district to be supplied, where land is most valuable, and that storage space for fuel must be provided), of buildings, and of shafting, bands, switches, resistance coils, and the other miscellaneous and delicate appliances required at such a station.

The committee have endeavoured to apply this knowledge to an area which nearly meets the requirements of electricians, and in which the gas supply can be defined. Market Hall Ward has been selected for this purpose as containing the principal public buildings. This ward covers an area equal to about 1,000 yards square, and, therefore, a little larger than that proposed by Dr. Siemens, but it has been necessary to take the whole, as information as to the number of lights in part of it only is not readily attainable. There are in the ward 3,570 consumers, who are using at a moderate computation from 100,000 to 120,000 lights. The length of mains in the ward is 19½ miles, and their value £13,500.

For the supply of gas for lighting in this area, the capital account, other than for distributive plant, but exclusive of meters, is ...		£155,000
Distributive plant—Mains ...	£13,500	
Services ...	1,500	
		15,000
Total ...		£170,000

It may, however, be noted that the cost of new gas works, specially erected for lighting such an area, including distributive plant and meters, ought not now to exceed £100,000.

The cost of electric plant for such a supply of (say) 100,000 lights can, from the information available, be estimated as follows:—

*Engines—The cost of engines, including boilers and settings, based on Mr. Crompton's estimate that 12,000 effective horse-power would be required for 50,000 lamps, is variously estimated by local engineers at from £210,000 to £240,000, say ...	£210,000
*Dynamo (Siemens), without reserves ...	150,000
Conductors, at £3,000 per mile ...	58,500
3,500 services (say) ...	5,000
	£423,500
Add. Buildings, Land, and Apparatus ...	
Total ...	£

The cost of meters is left out in both statements, as it is not yet known that a practical electric meter has been devised.

It will be seen from the foregoing statement, which the committee have been careful not to overestimate from the materials before them, that the minimum amount of capital that will be required must considerably exceed £4 per lamp. The committee think it most important to direct the attention of the Council to the fact that the only power to be obtained under the Electric Lighting Act is for the supply of electricity, and that the Act expressly prohibits any arrangement by which profit on any particular form of lamp can be made an integral part of the system of supply. It follows, therefore, that the question of profit to be made by undertakers, whether local authorities or electric-lighting companies, must be considered as solely appertaining to the supply. It cannot be doubted that when conductors have been laid in any area, each of the owners of lamps and apparatus which are protected by patent will urge the employment of a particular lamp, and that while a profit on the manufacture and supply of lamps would thus be secured to them, the undertakers would be left with what has been shown to be an inevitably costly portion of the business. Nor would it be possible to avoid this by the selection and recommendation of one form of lamp. The most sanguine supporter of electric lighting does not claim that the proposed system of distribution will be free, at any rate for some time to come, from difficulties, imperfections, or even failures. These would certainly be attributed by rival companies either to the use by consumers of the wrong lamp, or to the use by the undertakers of the wrong dynamo. It is conceivable that, the supply being in the hands of a local authority, with generating plant recently put down, consumers who had purchased costly fittings, and who were impatient under imperfections or difficulties which had manifested themselves in this experimental work, would demand that the dynamo in use should be abandoned in favour of some other form which for the moment attracted attention. It is also most

* Mr. Crompton estimated the cost of engines and dynamo at £11 5s. per horse-power.

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important to remember that whatever the cost of supplying electricity is found to be, the undertakers will be subject to great pressure by consumers to supply it at the same cost as gas, or, at the least, at prime cost. Local authorities having already the supply of gas in their hands will have additional difficulties in this respect, as, even if supplying electricity at prime cost, they will be suspected, especially by others seeking powers to establish a rival system, or by agents eager to sell lamps, of unduly keeping up the price in order to foster the gas supply.

Your committee are therefore of opinion that the subject of the Corporation undertaking the supply must be considered as a question of the general convenience and welfare of the public, and without reference to profits to be derived from it.

d. As to Obligations and Responsibilities.—The obligations which will be imposed on undertakers will not probably be onerous at the outset, although the committee think it desirable to point out that they may be more onerous under Sections 11 and 19 of the Electric Lighting Act than would at first sight appear, and they direct the attention of the Council to these two sections of the Act. In the former section it is provided that, unless with the consent of the Board of Trade, no local authority obtaining powers for the supply of electricity, and contracting with a company for the execution of these powers, shall divest themselves of any legal liabilities imposed on them in connection with such powers. It is, therefore, conceivable that a local authority might be placed in considerable difficulty under these circumstances by the default of a company with which it had contracted. The town clerk is of opinion that the meaning of Section 19 is not clear. It is, therefore, necessary to point out that under this section it may be contended that the undertakers will be under an obligation to supply electricity in any part of the selected area. In that event this would be a serious obligation, as it might, and probably would, involve the laying of conductors over the whole area for a very limited consumption.

Under any circumstances, however, the obligations imposed with regard to the public safety cannot fail, after the evidence submitted to the House of Commons Committee on the Bill, to be stringent, and they will at least impose serious responsibilities on the undertakers. There are other obligations in the Act which, while not onerous, will in all probability be the occasion of difficulty and expense, at least in the earlier stages of the experiment—those, for instance, in Section 17, which, though not new in Acts of Parliament, are now to be applied to new circumstances, and those in Section 26, for the protection of telegraph wires. It may be that the cost of laying conductors will be seriously increased by their removal becoming necessary on account of induction, and that the difficulties which the telephone companies have experienced in this respect will be much greater under the proposed application of electricity on a more extensive scale. Apart from the obligations imposed by the Act there are those which are definite under the Board of Trade rules with regard to applications for authority to supply electricity. All memorials for the grant of such authority are required, *inter alia*, to

Give a general description of the proposed works.

State the proposed conditions of supply, including price, nature and amount of supply, obligations to supply, &c.

State proposed provisions for the safety of the public.

State proposed capital, and how to be raised.

On consideration of these requirements, it is obvious that if the Council decided to apply for powers, they must at once obtain special professional help; that it would be necessary to rely solely on that help, and to accept the responsibility of taking action on technical and commercial matters involving heavy responsibilities, and possibly parliamentary opposition, without experience to guide them or their advisers in the matter.

There is, for instance, the difficulty of price. Dr. Siemens stated in his evidence before the House of Commons Committee that there is no practical self-registering electric meter in use, and all that is practicable at present is to regulate the maximum supply to each house. Your committee are of opinion that there would be considerable risk in accepting any recommendation on this subject. Or, again, on the question of works. If the precedent in gas legislation is followed, the site of the works must be stated in the order. It is possible that there may be considerable opposition to the establishment of such works in busy centres, while if the works are to be placed outside the district, economy of supply becomes impossible. The other requirements, especially that as to the provisions for public safety, for the sufficiency of which the local authority will probably be held responsible by the public in case of misfortune arising from oversight on the part of their advisers, appear to the committee to require very careful consideration on the part of the Council before they are voluntarily undertaken.

With regard to the capital, which cannot be estimated at less than £450,000 for the area selected for comparison, or £300,000 for an area of the size stated by Dr. Siemens to be the proper limit, it is not probable that the whole of it would be required at once. At the outset, however, a very large proportion of it must be expended. Sufficient land must be secured, and buildings large enough for extensions of plant erected. Large engines and dynamos must be provided, even if the engines have to be worked at first much under their capacity. Expensive conductors, of the size calculated for the ultimate supply when continued over the whole area, must be laid in the first instance. If these conditions are not observed, the chief objects of the experiment to be tried—viz., the possibility of supply over a sufficient area from a common centre, and the reduction of the cost of fuel and of the working expenses at the central station to the lowest possible point—will not be attained.

It appeared to the committee that, apart from all other circumstances, it is not probable that the Council or the town would sanction an application to Parliament for power to expend £300,000 on an experiment of this kind. They have therefore inquired whether a smaller installation could be made, and at what minimum expenditure of capital it could be undertaken without sacrificing economy of production. It is not probable that the town will accept as a satisfactory trial any experiment that does not make provision for the supply of the Town Hall and the public buildings around it. Assuming that the capital expenditure for a small installation would be in the same proportion as for a larger one, a capital of £100,000 would provide 22,000 lamps, a smaller number than that stated by any of the scientific witnesses before the House of Commons Committee to be the minimum which could be supplied with the greatest economy. Of this number about 5,000 would be required to supply the Town Hall and the group of public or semi-public buildings in its immediate neighbourhood, leaving 17,000 for private lighting, without arc lamps. This would be less than the number of lights now used in New-street and High-street, including provision for the ordinary lighting of the Theatre Royal, and omitting the Exchange, New-street Railway Station, and Queen's Hotel.

Apart from the loss of economy which would result from the necessity in this case of placing the generating station on the outside of the district of supply, such an installation would have but little practical value as an experiment. It would be useless as a test of the size of the ultimate area which could be lighted. It would be inconclusive as to the effect of adding new supplies to conductors of varying sizes and lengths laid over a large area, and probably as to the difficulties of regulating the current to meet a varying demand.

e. As to such a supply being a public necessity.—The committee do not think it can be said that electricity is at present a public necessity. Dr. Siemens has said that electricity is the light of luxury, and that gas is, and will be, the poor man's friend. The committee, not differing with Dr. Siemens, quote his authority in support of their opinion, and are unable, so far as regards this reason, to recommend the expenditure of any portion of the corporate funds in an experiment for the advantage of a portion only of the community.

Your committee, having regard to the difficulties and grave responsibilities which, in the present state of knowledge on the subject, appear to be inseparable from the undertaking, have considered whether any disadvantages would result to the town if the support of the Corporation is given to the grant of authority to electric lighting companies to undertake the supply. They report, after careful consideration of this subject, that it does not appear to them that the ratepayers will be in any way prejudiced by the establishment of one or more companies in limited areas of supply. They are of opinion that the competition with gas at local prices will impose a sufficient limit to the price of electricity, that it will be possible to make due provision under such a concession for the retention by the Council of full control over the public streets, and to secure immediate progress with the installation, and that it will not be difficult to arrange that the concession shall be made for a moderate term.

Reviewing these considerations, the committee are of opinion that there is no analogy between the proposal that the Council should undertake the supply of gas and that they should undertake that of electricity, and that in most important particulars the circumstances are wholly different. The Council were prepared, and indeed thought it advisable, to accept largely increased responsibilities with the transfer of the gas undertaking, but those responsibilities were chiefly as to the commercial conduct of the business. They had as a part of the tranfer a trained and skilful staff, with long experience of the business, on whom they could rely. Their first responsibility with regard to the supply of electricity would be the selection of an untried staff, chosen of necessity from men without experience of the obligations to be incurred, and for whose mistakes the Corporation would be held blameable. With the transfer of the gas supply, profits over and above those possible to the companies were at once at the disposal of the Corporation. The result of an undertaking to supply electricity would almost certainly impose an immediate burden on the ratepayers, with the ultimate prospect of a considerable loss. It is known that the principal difficulties of the proposed system lie in the distribution of electricity. Apart from cost, the difficulties of the generation of electricity and the construction of lamps, may be said to have been overcome. A local authority undertaking the supply of electricity under the most favourable circumstances would have on its hands the costly and difficult part of the supply. It would, however, be serving the interests of companies whose profits are made by royalties on or the manufacture of dynamos, plant, and lamps, who would be able to attribute all the imperfections and failures of the system to the source of supply, and to whose interest it would be to foster a continual agitation for cheaper electricity. The committee believe that no sufficient reason can be shown to induce the Corporation to enter on a work which cannot fail to bring it anxieties, difficulties, and arduous labours, without the recompense of contributing to the welfare of the community as a whole, and which would involve financial resposibilities, with the uncertainty of adequate, if any, return. If, on the other hand, the companies are allowed to take the management of the supply, they will undertake also the responsibilities and difficulties appertaining to it. At the end of the term which is agreed upon, or which Parliament determines, as sufficient compensation to the company, the Corporation will have the same opportunity, but on more favourable terms of acquiring the property, and will, if it has become profitable, have the same inducement in the saving of interest on capital employed as it had when it purchased the gas undertaking.

The committee believe, however, that gas, when properly used, will hold its own as the most effective and reliable illuminant, and that it is possible to free it from much of the opposition to which it is now liable, by showing on every opportunity that the objections urged against it are not inseparable from its use, and they suggest to the Council that no opportunity should be lost of requiring in their own buildings sufficient provision for ordinary ventilation, as well as facilities for the proper application of gas when employed as the lighting agent.

Your committee, after full and careful consideration of the subject, recommend—1. That no application be now made by the Council for authority to supply electricity in the borough, or in any part of the district of their gas supply, either by license or provisional order under the Electric Lighting Act, or by special Act of Parliament. 2. That your committee be authorised to enter on negotiations with the companies applying for powers to supply electricity within the borough, for the purpose of securing in the license or order sufficient provision for the retention by the Council of the full control of the streets, for the adoption of suitable sites for the works, for the safety of the public, for ensuring the completion of the installation within a limited time, and for the limitation of the term of the concession. 3. That, subject to satisfactory conditions being arranged with the companies in this way, your committee be authorised to support, on behalf of the Council, applications to the Board of Trade by one or more of the companies for power to supply one or more limited areas within the borough. 4. That, subject to the foregoing recommendations, your committee be authorised to oppose all or any of the applications of which notice has been given to the Council.

Your committee report that they have, in pursuance of the instructions

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of the Council, been in communication with the companies who have given notice of their intention to apply for parliamentary authority to supply electricity within the borough, but that the information which they have received from them is not sufficient to enable the committee to report fully to the Council at this meeting on the subjects of the inquiry.

Accompanying the above report is a report by the town clerk, explaining the provisions of the Electric Lighting Act, 1882, and giving a copy of the rules recently issued by the Board of Trade.

THE ELECTRIC "SUN" LAMP AND POWER COMPANY (LIMITED).

The first ordinary meeting of this Company, pursuant to the Companies Acts, was held at the City Terminus Hotel, Cannon-street, on the 24th inst., Sir James Carmichael in the chair.

The Secretary, Mr. A. F. PENNELL, having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, my first duty is, on behalf of our chairman, Lord Brabourne, to offer you his apologies and regrets at his unavoidable absence to-day. He is unfortunately suffering from an attack of gout. You are all aware, gentlemen, that this is only a formal meeting —which is called the statutory meeting—held under the Act which compels the holding of a meeting, I believe, three months after the formation of a company; and at this meeting no report or accounts are submitted to the shareholders. At the same time I think it will be satisfactory to you for me to state very briefly the present position of the Company, and what we are doing, and I shall be happy to answer any question or give any information that may be desired by the shareholders. Gentlemen, you are aware by a circular issued to the shareholders some time ago that a modified agreement was made with the inventor and patentees of the "Sun" lamp. This was occasioned by the whole of our capital not being subscribed. In round figures about half the shares—7,663— were allotted, representing something like, in round figures, £40,000. Under our original contract with the patentees and inventors we were, as you are aware from the prospectus, to have given them £50,000 in cash and £50,000 in shares for the patent rights. As we received only £40,000 in cash that became impossible, and immediately, before allotment or taking any steps, we met the inventors and patentees to know what modified terms they were prepared to offer to the Board to induce them to go on with the thing, in which we had and have every confidence. I am bound to say that they met us in a very liberal spirit, and immediately reduced the cash payment from £50,000 to £40,000, thus taking off £10,000. They went further, and said, "Out of the £40,000 we shall be content, at the present moment, to receive £7,500 in cash for our patent rights, leaving the balance to be paid as you issue further capital." First of all, we may issue further capital to the extent of £10,000, which we keep to ourselves, and then beyond that, if we issue new capital, we give them half, retaining half ourselves, till we pay them all that is due to them. But that agreement only remains in force till the end of December next year, 1883, and if by that time we have not paid the balance in cash they are bound to take the whole of the balance in shares. That I think shows that the inventor and patentees have great confidence in the undertaking, because, beyond the £7,500, they are liable to be paid wholly in shares; and that £7,500 includes all the expenses of exhibiting the light in the country, and all the expenses of advertising the Company— all expenses, in fact, up to the date of allotment. The inventor and patentees have, therefore, behaved in a very liberal spirit, and I do not think that any company of the same nature as ours has ever been started with such fairness as to the patent rights. Since the allotment, gentlemen, we have been doing our best to get things into shape in order to get to work, but I need not tell you that, with a new thing like this, we are obliged to move somewhat slowly. In the first place we had to organise an efficient staff, which has been done, and then we had to look about for some suitable central premises in London for workshops, &c., where we could exhibit our light, and call the attention of future customers to its merits. We have now succeeded in getting what we consider very suitable premises in the central part of the West End of London—in Riding House-street, just behind Langham Church, close to Oxford-circus, where we hope in the course of next month, about the middle of the month, to ask you to come to see the light in full operation. So far, we have not been in a position to take any large orders, because, like every other company of this sort, we have been delayed. There is a great demand for dynamo machines, and all the necessary apparatus connected with electric lighting, and we have had to wait some time to get those orders executed. There has been another important reason for delay in our entering into any contracts, and that is that the inventor of the "Sun" light, a Belgian engineer, M. Clerc, has ever since been making improvements, and one or two of them are of a very satisfactory character. Therefore, we did not like to put up a light that we might have to take down again. I believe now that he has a light which is very much better in various respects than the one we originally purchased. You are aware that all his improvements and everything he may invent will all belong to this Company—we are entitled to every improvement of the inventor connected with the lamp which he may bring out. I think I have now stated pretty clearly the position of the Company, and I do not know that I need add anything more. It is suggested by my colleague, Mr. Brand, that one matter we have rather been delayed about is the action of the vestries, which you all know of. Each vestry is now taking its own view respecting the electric light. Some wish to go in for the lighting themselves, and some wish the companies to tender. That has delayed us. We have applied to the vestry for permission to lay down our pipes and do the work from our central station at Riding House-street, and we have great hopes of getting that permission. That is the position of matters as to the vestries. If we get this license from the vestry we could light the greater part of Regent-street from our offices. That would be a very important street to light. I shall now be happy to answer any question which any shareholder may wish to ask me. Now that we have got into shape, and the thing is properly organised, we hope very soon to be able to tell you—at least by our next meeting—that we have contracts in hand. At present we have a great number of applications, but we have not yet been in a position to take any absolute contract.

A SHAREHOLDER inquired whether their light was not intended more for interior uses—the lighting of shops and buildings, for example. Was it qualified for lighting streets?

The CHAIRMAN: I think it is, but you are right in your first remark. Our speciality would be more suitable for large buildings—mills, workshops, and shops of every description—than for public lighting. At the same time there is no reason why it should not be a very useful public lamp in the streets. It has never yet been tried as a public light.

The SHAREHOLDER asked whether it was good policy for them to light up Regent-street?

The CHAIRMAN: You misunderstood me. My idea was to light up the shops in Regent-street. In reply to a further question, he added: I do not think there would be any object in our exhibiting at the Crystal Palace. We hope to do something more practical than that. It would cost a great deal of money. I think our publicly exhibiting it in London would really be more valuable than sending it down to the Crystal Palace. We have four lamps burning now at *The Times* office. That is a good advertisement.

A SHAREHOLDER asked if the Company was likely to get a quotation soon on the Stock Exchange.

The CHAIRMAN: That is a question we have not gone into yet. We shall try to obtain a quotation when the proper time comes.

The SHAREHOLDER inquired the number of shares allotted.

The CHAIRMAN: 7,663.

The SHAREHOLDER: Out of how many?

The CHAIRMAN: 20,000 shares is the total number we are authorised at first to issue; that is, out of 40,000. Eventually we shall have plenty of capital to fall back upon if we want it, and I hope we may. The bankers' certificates are ready to-day to be exchanged at the office.

On the motion of Colonel S. BURNEY, a vote of thanks was passed to the chairman for presiding.

The CHAIRMAN having acknowledged the compliment, the proceedings terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	Closing Prices Oct. 25.		Business Done Week Ending Oct. 25. Highest.	Lowest.
Anglo-American	49,	50	50	49
Do. Preferred	80,	81	82½	80⅜
Do. Deferred	18½,	19½	20	18½
Brazil Submarine	12,	12¼	12¼	12
Cuba	9¼,	10¼	9⅞	9⅞
Do. Preference	16,	17	—	—
Direct Spanish	6,	6½	—	—
Do. Preference	15½,	16½	15⅝	15¾
Direct United States Cable	11¾,	12¼	12⅛	11 15-16
Eastern Telegraph	10½,	10¾	10¾	10 9-16
Do. 6 per Cent. Preference	12¾,	13	13	12⅝
Do. 5 per Cent. Debentures, 1899	101,	104	—	—
Eastern Extension	11⅜,	11⅝	11⅝	11⅜
German Union	9¾,	10¼	10¼	10 1-16
Globe Telegraph and Trust Company	6½,	6¾	6¾	6 9-16
Do. Preference	12½,	12¾	12¾	12 9-16
Great Northern	12¼,	12¾	—	—
Indo-European	31,	32	—	—
Mediterranean Extension	1¾,	2¼	—	—
Do. Preference	8,	9	—	—
Reuter's	12½,	13	—	—
Submarine	245,	255	—	—
West India and Panama	1⅜,	1⅝	1½	1 7-16
Do. 1st Preference	7,	7½	7⅝	7
Western Brazilian	7⅛,	7⅝	7¼	6⅛
West. Union 7 per Cent. 1st Mortgage	123,	128	127½	127½
Do. 6 per Cent. Sterling Bonds	100,	103	102	102

TELEPHONES.

Consol. Telephone and Maintenance	1,	1¼	1 3-16	1 1-16
Oriental	¾,	1	15-16	11-16
United Telephone	10¾,	11¼	11⅛	10¾

ELECTRIC LIGHT.

Anglo-American Brush	10½,	11	13	10¾
Maxim-Weston	½,	¾	⅝	½
Eastern Electric	2½,	3	3	2½

TRAFFIC RECEIPTS FOR SEPTEMBER, 1882.

COMPANIES.	Sept., 1882.	Sept., 1881.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,250	2,030	220	—
Direct Spanish Telegraph Company	1,812	1,790	22	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	32,955	30,866	2,089	—
Eastern Telegraph Company	57,271	47,407	9,86	—
Great Northern Telegraph Company	21,280	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

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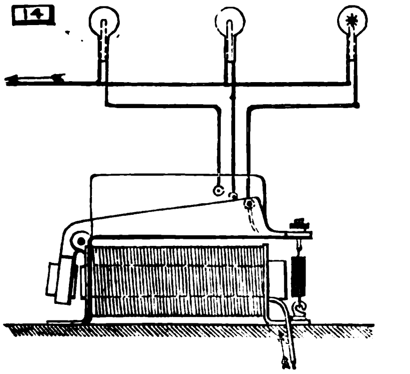
RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

14. IMPROVEMENTS IN APPARATUS USED FOR ELECTRIC LIGHTING, *A. Mackie, Pimlico, London.—2nd January*, 1882. 6*d*.

This relates to an apparatus for preventing any one of a series of incandescent lamps in a circuit from being overheated and destroyed by an excess of current. All the positive terminals of the lamps, when in multiple arc as in the illustration, are connected to studs fixed in insulating material

14

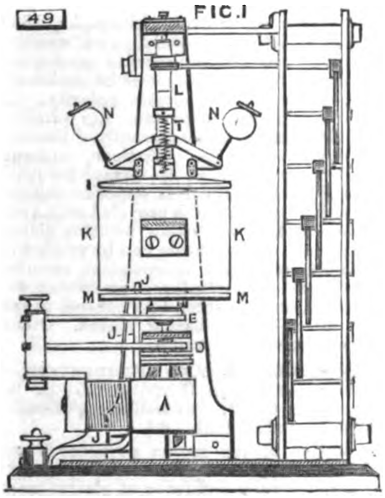


as shown. A sliding contact piece is attached to a spindle connected with the armature of an electro-magnet. The current passes through this magnet, and according to its strength as compared with that of the opposing spring, so the armature is attracted and one or more studs covered by the contact piece, and consequently one or more lamps supplied with current.

49. IMPROVEMENTS IN MEASURING AND RECORDING QUANTITY OF ELECTRICITY, &c., *J. Hopkinson, F.R.S., Westminster.—4th January*, 1882. 6*d*.

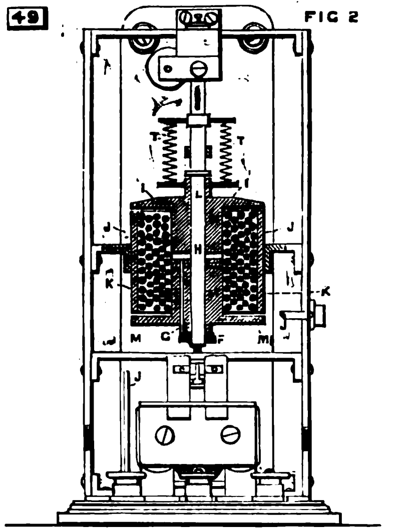
This relates to apparatus for measuring the whole quantity of electricity passing through a conductor. In Fig. 1, A A are the magnets of a small dynamo used as a motor. This dynamo is arranged with fine wire as a shunt to the current to be measured; this derived current passes through magnets A, by one brush to the armature, thence by brushes D and E to the insulated F (see Fig. 2), through wire G, to an insu-

49 FIG. 1



lated ring, H. Here the circuit can be made or broken, according as core I be lowered or raised; J is a coil of wire through which the current to be measured passes; it is surrounded by iron tube, K, supported by the framework; L is a shaft driven by the electro-motor, carrying an iron case, M, fixed to the shaft; N N are governor balls which by levers and links raise I, which revolves with shaft L, and can slide upon it. The revolutions of L are counted by worm and worm-wheel, connected with pinions, wheels, and dials as shown. Springs T take the weight of I, and are so adjusted that when no current passes through J contact is broken with insulated ring H, but that a small current through this coil will make contact and cause the electro-motor to begin to revolve. When a current passes through J, it causes attraction between K and the flanges of of the moving cores M and I; also between the cores M and I the magnetic force upon I is vertically downwards, and is proportional within limits to the square of the current in the coil.

49 FIG 2

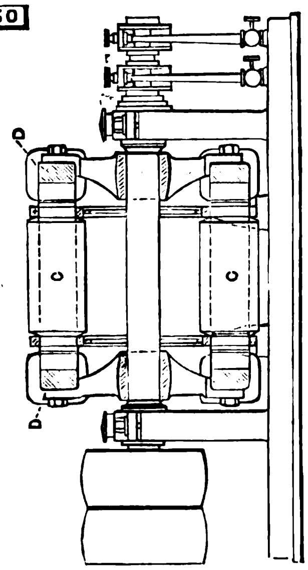


When the governor is revolving, the centrifugal force on the balls is proportional to the square of the speed of revolution, and tends to lift I in opposition to the magnetic force. These forces balance one another, the result being that the system will revolve with a velocity proportional to the current through the coil.

130. IMPROVEMENTS IN MACHINERY AND APPARATUS FOR OBTAINING, &c., ELECTRIC CURRENTS FOR ELECTRIC LIGHTING, &c., *W. T. Henley, Plaistow. — 10th January*, 1882. 1*s*. 6*d*.

The first part of the invention refers to a dynamo machine, consisting of straight electro-magnets fixed in two brass standards, with a ring of iron made to revolve at each end of these magnets, the rings having recesses for coils of wire. The machine has six distinct electro-magnets revolving at each end of the fixed magnets, the polarity of which changes six times in each revo-

130

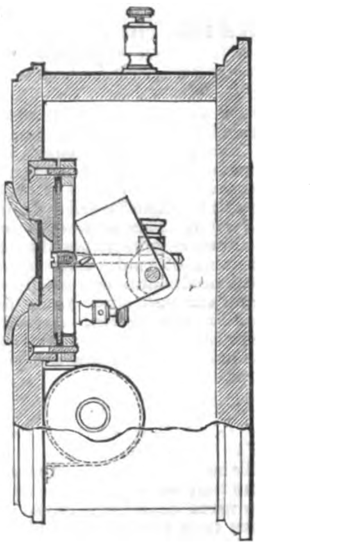


lution of the ring. The inventor sometimes constructs his fixed magnets of iron tubes filled with fine soft iron wire instead of making them of solid iron. The figure shows a longitudinal section of the machine. C C are two of the six fixed magnets, D D the revolving rings with their coils. The second part of the invention relates to an arc lamp, of which various modifications are described and illustrated. The carbons are fed forward by a weight and cord, a train of wheels, and an electro-magnet in a shunt circuit regulating the arc. Another electro-magnet establishes the arc.

316. IMPROVEMENTS IN TELEPHONE TRANSMITTERS, *E. G. Brewer, London.—21st January*, 1882.—(*A communication from J. Olmsted, New York.*) 6*d*.

This invention relates, first, to a novel construction of telephone, in which is employed a series of independently pivoted electrodes forming together a compound electrode, resting against an opposite electrode by their own gravity

316

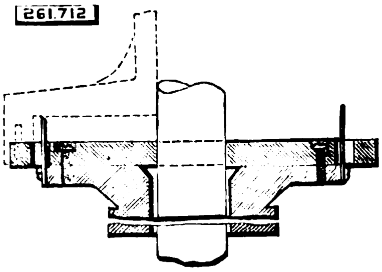


and mounted upon an adjustable support, whereby the same initial contact is secured for all; secondly, in a novel contact or electrode composed of a thin sheet of carbonised paper, or a number of such sheets arranged side by side, mounted so as to rest against the opposite electrode. The figure represents a partial vertical section of an instrument so constructed.

261,712. COMMUTATOR FOR DYNAMO-ELECTRIC MACHINES, *William Hochhausen, New York, N.Y.—Filed March* 2, 1882.

Brief.—To avoid the difficulties which arise from the warping of the disc supporting the com

261,712



mutator plates in commutators of this character when heated by the action of the machine, the inventor employs a disc of stone, which is practically unaffected by this cause.

261,850. MAGNETO-ELECTRIC MACHINE, *Otto Heikel, Jersey City, N.J., assignor to the National Electric Light and Power Company, New York, N.Y.—Filed May* 2, 1879.

Claim.—(1) The commutator made of separate segmental blocks, with flanges between separate grooved rings, loose upon a tube or shaft, and clamped by a nut at the end of the tube or shaft, there being a space between the plate and shaft for the circuit wires, substantially as set forth.

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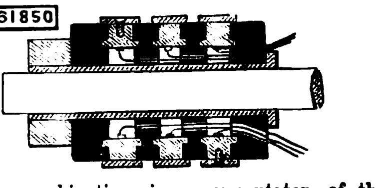

(2) The combination, in a commutator, of the segmental blocks with flanges, the insulating rings grooved to support the blocks, a central tube or shaft smaller than commutator, and leaving a space beneath such blocks for the insulated wires, the nut to clamp the blocks and rings, and the removable faces to the commutator, substantially as set forth.

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29. Secondary Batteries, *D. G. FitzGerald, C. H. W. Biggs, and W. W. Beaumont.*—3*rd January*, 1882.—(*Not proceeded with.*) 2*d.*

Electrodes are obtained by utilising local action.

55. Apparatus Used in the Distribution of Electrical Energy, *J. Perry.*—5*th January*, 1882. 4*d.*

Magneto-electric machines are used in series with dynamo machines.

64. Improvements in Magneto and Dynamo-Electric Machines, *L. A. Groth, Finsbury Pavement, London.*—5*th January*, 1882.—(*A communication from R. J. Gulcher, Biala, Austria.*) 6*d.*

This relates to improvements in magneto and dynamo machines, whereby heating effects are reduced. The inductor rotating between the magnetic poles consists of a ring formed of separate insulated plates of soft iron to facilitate the change of the magnetic poles during the rotation of the ring. This allows the wires wound round the inductor to be exposed to the inducing action of the magnetic poles from all sides, thereby obviating the production of heat by the passage of the current through those parts of the wires not exposed to this action. Arrangements are also made for the flow of air through the ring. The poles of the inducing magnets are also of a U or channel form.

69. Manufacture of Incandescent Lamps, *E. H. T. Liveing and C. V. Boys.*—6*th January*, 1882. 4*d.*

For the filament of small lamps capillary coke is used. Instead of platinum connections, the conducting wires pass through a long narrow tube, and are connected with well-boiled pitch or resinous cement, and the parts are made so as to be replaceable.

118. Improvemrnts in Telegraphy, *P. Jensen, Chancery-lane, London.*—9*th January*, 1882.—(*A communication from F. W. Jones, New York.*—*Not proceeded with.*) 4*d.*

This relates to duplex cable telegraphs, and the objects are to overcome the disturbing effects of the electrical discharge from the cable upon the receiving instruments, and to avoid the difficulties arising from the use of a check for the static discharge in the shape of an electro-magnetic coil placed in the main circuit.

120. Storing Electrical Energy, *J. E. Liardet and T. Donnithorn.*—9*th January*, 1882. 8*d.*

Small particles of chalk, salt, &c., are covered with lead; then the interior removed, leaving a porous mass. Charcoal, coke, &c., are covered with porous lead by electrolysis. Cells are made by filling the interior with finely-divided lead. Various other ways of making up the electrodes with finely-divided lead are described.

129. An Improved Method and Apparatus for Electrically Lighting Railway Trains, *W. H. Preece, Wimbledon, and J. James, Lambeth, Surrey.*—10*th January*, 1882. 6*d.*

This consists in the combination of air compressors and reservoirs with dynamo machines and lamps. The reservoirs are charged with compressed air by compressing pumps worked from one of the train axles. This compressed air works engines, which in turn work the dynamos, by which current is supplied to the lamps connected with them by suitable wires, and which latter are distributed as required through the train.

144. Secondary Galvanic Batteries, *H. J. Haddan, London.*—11*th January*, 1882.—(*A communication from Dr. E. Boettcher, Leipzig.*)—(*Not proceeded with.*) 2*d.*

Relates to the use of zinc vitriol as exciting liquid, and of zinc and oxide of lead as electrodes.

169. Improvements in Electro-Motors and Dynamo-Electric Machines, &c., *H. S. Raison, Bayswater.*—12*th January*, 1882. 8*d.*

The inventor constructs his motor of two parts, both of which revolve, the one in an opposite direction to the other. They are made in the form of two spherical balls, which contain the magnets. The inner ball is fixed on the shaft. The outer ball is in two parts, built up in segments and bolted together, having two pole pieces, and being wound with wire in the same manner as the inner ball. The outer ball is consequently free to rotate round the inner one, and the latter revolves inside the outer, but in an opposite direction. The power is taken from them by pulleys, one attached to the shaft of the inside magnet, and the other to the shaft of the outer coil.

178. Improvements in Apparatus for Signalling upon Railways by Means of Electricity, *C. E. Spagnoletti, Maida Hill, London.*—12*th January*, 1882. 6*d.*

This relates to improvements in railway signalling, which are particularly suitable for working junctions and large station yards. The inventor claims a special lever with electrical connections for controlling any or all levers required in the signal-box for any purpose. The system of working lines by locking by one action at either end both starting or other signal levers for up and down trains at each end of the single line section; also the mode of making and breaking contacts by divided armatures and by pins and springs on armatures. A pneumatic contact maker, blocking and locking instrument, rolling contact fitted to trains, and apparatus for resetting the contact pieces, &c.; also arrangement for warning the driver on approaching the signal, all of which are described and illustrated in the specification.

185. Electric Accumulators, *H. J. Haddan, London.*—13*th, January*, 1882.—(*A communication from A. Morel, Roubaix, France.*)—(*Not proceeded with.*) 2*d.*

The gases produced by the current are conserved and recombined.

234. Improvements in and Relating to Dynamo-Electric Machines, *W. R. Lake, London.*—17*th January*, 1882.—(*A communication from C. A. Hussey and A. S. Dodd, New York.*) 6*d.*

The improvements consist, first, in the combination in a dynamo of a field magnet and an armature severally having cores composed of arc-shaped portions wound with wire, intervening arc-shaped portions and radial portions connecting the two series of arc-shaped portions; the radial portions of both the field magnet and armature forming poles, polar extensions or consequent points, and extending towards each other. The field magnet core is preferably made of one integral piece of metal and the armature core of many thin pieces. Another improvement is a means whereby the machine may be made to produce continuous instead of alternate currents, which is accomplished by means of a suitable switch.

215. Improvements in Apparatus for Regulating Electric Currents, *W. R. Lake, London.*—17*th January*, 1882.—(*A communication from A. de Khotinsky, Paris.*) 6*d.*

This invention consists in the combination with an exciting machine and a dynamo-electric generator of a regulator consisting of an auxiliary electro-motor connected with the principal circuit, and actuating a lever fixed on the shaft of its armature, the said lever being provided with a spring or weight which counter-balances the action of the motor, and carrying at its opposite end a small conducting rod which closes a shunt circuit consisting of a vessel of some liquid, the resistance of which varies in proportion to the height of the liquid in the vessel. So long as the intensity of the current remains constant the lever will not change its position, but when the intensity increases the lever will descend, the rod touch the liquid, and a shunt circuit be established in the current of the armature of the exciting machine.

278. Improvement in Means for Effecting Electro - Hydro - Therapeutic Treatment of Patients Affected by Disease, *W. A. Barlow, London.*—19*th January*, 1882.—(*A communication from L. Encausse and Canésie, Paris.*) 6*d.*

This relates to method for combining the treatment of disease by cutaneous absorption and by electricity, and to a special chamber and apparatus for carrying out the invention.

289. Improvements in Secondary Batteries, &c., *J. Humphrys, Norwood.*—20*th January*, 1882. 4*d.*

The inventor makes his plates of an open lattice form. He connects the sides of the framework of each plate with bars either of diamond or oval section, these bars being arranged at an angle on the Venetian blind principle, thereby exposing a maximum area of spongy lead to the action of the liquid.

319. Construction of Secondary Batteries, *J. S. Sellon, London.*—21*st January*, 1882. 2*d.*

Relates to supports or frames employed in secondary batteries.

290. A New or Improved Application of Telephonic Conductors and Apparatus Therefor, *H. J. Haddan, Kensington.*—20*th January*, 1882.—(*A communication from J. D. Morel, Roubaix, France.*)—(*Not proceeded with.*) 2*d.*

This relates to the combination of a telephonic conductor with a phonograph by utilising the telephonic conductor for producing an induced current in a wire passing round an electro-magnet, which attracts an armature whenever the main circuit is closed, thereby closing another circuit produced by a battery, and passing round a second electro-magnet which moves the pointer of the phonograph.

392. Improvements in Obtaining Light by Electricity, &c., *W. P. Thompson, Liverpool and London.*—26*th January*, 1882.—(*A communication from the Union Electric Manufacturing Company, New York.*) 6*d.*

This relates to an arc lamp in which the upper carbon is connected with a regulating apparatus, consisting of a drum, mechanically connected with the carbon holder, and an armature and clamping lever connected together and pendulously suspended from the axis of the said drum, this lever being intended to act against the inner periphery of the drum, when the armature is attracted by an electro-magnet placed close to it, wound with thick and thin coils, and placed in the main circuit.

1437. Electric Accumulator, *S. Cohné, London.*—25*th March*, 1882. 4*d.*

Mercuric sulphide—H_9 S—or sulphate of mercury—$H_9{}^2O\ S\ O^3$—are used to place upon the lead electrodes.

5660. Improvements in Electric Lamps, *L. S. Powell, Notting Hill, London.*—24*th December*, 1881.—(*A communication from J. M. A. Gérard-Lescuyer, Paris.*) 6*d.*

In this lamp the descent of the upper carbon is regulated by its being attached to a piston working in an air cylinder; as the carbon descends a partial vacuum is produced behind the piston, which retards its descent. The admission of air into the cylinder is controlled by a valve. The cylinder is situated in the centre of an electro-magnet in a shunt circuit. The carbons are separated by an armature of this magnet, and a brake worked by the same magnet is provided to arrest the descent of the upper carbon. The weight of the lower carbon and rods is supported by two helical springs attached to the upper part of the lamp.

5674. Improvemfnts in Transmitting and Receiving Apparatus for Type-printing Telegraphs, *S. Pitt, Sutton, Surrey.*—27*th December*, 1881.—(*A communication from H. van Hoevenbergh, Elizabeth, New Jersey, U.S.A.* 10*d.*

This relates to printing telegraphs, the type wheels of which are impelled by a weight and wheel work, and the progressive movements of which are controlled by a series of electrical pulsations, alternately of opposite polarity. In the inventor's improved apparatus the printing is effected by increasing the strength of the current during some one of the pulsations, without reference to its polarity, at the instant the required division of the type wheel is opposite the platen. The printing instrument is provided with a double type wheel and an oscillating printing platen, so that either one of the wheels can be printed from. For this apparatus two independent circuits are required, one to control the movement of the type wheels, and the second to control the angular position of the oscillating platen. Other improvements are also described.

5687. Controlling and Regulating the Production and Distribution of Electricity, *C. A. Carus-Wilson, London.*—27*th December*, 1881. 8*d.*

The action of the engine governor is supplemented. A weight is made to bear on it, and this weight is under the influence of electro-magnets or solenoids. Another part of the invention is to use secondary batteries in a circuit between the main and earth, and charge them when too great an E M F is otherwise obtained.

5743. Improvements in Electrical Resistances, *G. Pfannkuche and R. E. Dunston, Fitzroy-square, London.*—31*st December*, 1881. 6*d.*

This relates to a device for rendering resistance coils more handy and inexpensive, by embedding the wires in plaster of Paris or glass, so that the heat engendered in them may be readily diffused. By this means it is claimed that smaller wires than at present in use can be employed.

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SLIP

New Cable to Tripoli.—The Eastern Telegraph Company have opened the new cable between Malta and Tripoli for traffic.

Brazilian Submarine Telegraph Company. — The traffic receipts of this company for the week ended October 27th were £3,581.

Brazilian Submarine Telegraph Company.—The traffic receipts of this company for the week ended 27th October amounted to £3,581.

British Guiana. — The cable between Trinidad and Demerara is broken. Telegraphic communication with British Guiana is, therefore, interrupted.

Leeds Telegraph Office.—The number of telegrams passing through this telegraph office during last year was two millions two hundred and twenty thousand.

Electric Lighting for Stockport.—The Town Council of Stockport have decided to apply to Parliament for a provisional order empowering them to supply electricity for various purposes.

Crystal Palace Exhibition.—The amount subscribed by the gas companies towards the expenses of the special committee of the Gas Institute in connection with the above exhibition now amounts to £5,436 16s.

Music Wire.—We are informed that Messrs. Felton and Guilleaume, of Mülheim, on the Rhine, and 101, Leadenhall-street, E.C., have opened a special department for the manufacture of their patent steel music wire.

Electric Light at Holborn.—The Holborn Restaurant has been completed, and is to be lit throughout by the Edison Electric Light Company. About 1,000 lamps in all will be used, partly of 8 and partly of 16-candles.

Eastern Extension Company.—The traffic receipts of the Eastern Extension, Australasia, and China Telegraph Company for the month of October, 1882, amounted to £29,925, and to £31,164 for the corresponding period of 1881.

The Edison System in America.—We learn that there are 123 isolated plants on the Edison system now running, or in process of being fitted up in various parts of the United States. These plants give an aggregate number of 21,998 lamps.

Rochdale and Electric Lighting.—The Town Council of Rochdale have decided to make application to the Board of Trade for a provisional order authorising them to supply electricity for public and private purposes within the borough.

Western and Brazilian Telegraph Company.—The traffic receipts of this company for the week ending 27th October, 1882, were £2,365, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited).

Electric Light in Gasworks.—It is said that the gas company of Ghent in Belgium have fitted up some Nothomb incandescent lamps for the purpose of lighting some of their rooms in which work is carried on during the night. We do not know how the necessary power is obtained.

West India and Panama Telegraph Company.—The estimated traffic receipts of this company for the half month ended Sept. 30th are £1,729, as compared with £1,616 in the corresponding period of 1881. The estimated receipts for Oct. 15th are £1,605, as compared with £1,693 in 1881.

Society of Telegraph Engineers and of Electricians.—The first meeting of the autumn session of this Society will take place on Thursday, November 9, at 8 p.m., when a paper will be read on "The Munich Electrical Exhibition, 1882," by W. H. Preece, F.R.S., Past President.

Electric Lighting at Poole.—The Poole School of Art and Science Annual Exhibition was held during the past week. The hall was lighted up each evening by six Pilsen lamps, with satisfactory results. The current was generated by a Schukert dynamo. The work was carried out by Mr. R. Bayley, of Bayley and Sons, Poole.

Electric Light at Waterloo Station.—The Windsor platform of the Waterloo Bridge station is about to be lit with Edison lamps. About 300 B or 8-candle lamps will be used, the current being furnished by an Edison L dynamo, driven by an Armington and Sims' engine. The directors' room will also be lit from the same plant.

Cuba Submarine Telegraph Company.—The number of messages passing over the lines of this company during the month of October was 2,172, estimated to produce £2,000, against 2,145 messages, producing £2,192 in the corresponding month of last year. The traffic receipts for the month of July, estimated at £2,800, realised £2,921.

Cable Repaired.—The West Coast of America Telegraph Company inform us that communication by this company's cable between Lima and Mollendo was restored on the 30th October, and that messages can now be sent through the Atlantic Cable Companies, *viâ* Galveston, direct to Valparaiso and elsewhere in Chili and the Argentine Republic.

Mr. Edison's Patents.—On the 22nd of August last 18 patents were issued to Mr. Edison by the United States Patent Office; on the 5th September 1; on the 19th September 31; on 3rd October 1; and on the 10th October 12, or 63 in all. The total number of patents issued to him up to 14th October was 149, in addition to which he had no less than 135 applications lodged for additional patents.

Cost of Electric Lighting.—In a recent report to the Boston Board of Aldermen, the Superintendent of Lamps in that city, says that there are 103 electric lights now in use in the city at a cost for maintenance of 23,108dols. The electric lights have displaced 325 gas lights, of which the cost of maintenance was only 9,779dols. These figures would be more valuable if the systems and candle-power were mentioned.

Time by Telephone.—At Ann Arbor, Mich., astronomical time is furnished by the observatory to subscribers daily at 9 o'clock a.m. by telephone. The telephone transmitter at the observatory is placed close to a Morse sounder, which is operated automatically by the observatory clock. From 8:58 to 8:59 the sounder clicks once for each second, and from 8:59 to 9 o'clock twice for each second. At 9 o'clock it ceases. The click of the sounder is heard distinctly in the receiving telephones of the subscribers.—*Operator.*

Is it True?—An American paper says:—"There was excitement in front of the Central Methodist Church, Market-street, Newark, N.J., on Saturday evening last. Adjoining the church is a building with iron columns, which is supplied with electric light, and somewhere in the circuit a telegraph wire had fallen upon the electric wire, thus charging the building near the church. The current extended to the iron fence outside, and four persons who had touched the fence in passing had been knocked down. They were not seriously injured."

Kelway's Electric Log.—We are glad to be able to record a very successful trial of this log, which took place on Wednes-

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day last, Nov. 1. The log was arranged on board the steam tug "Pixie," and the result of the trials was that the mean of the mean differences, according to the Admiralty method of computation, showed the log gave a too slow indication by ·0044, or forty-four ten thousandths. The result by the mile was 7·2768 nauts, the result by the log 7·2724, a difference, as we say, of ·0044. This we do not hesitate to say is practically accurate, and we congratulate Mr. Kelway upon having obtained such good results.

TELEGRAPHIC COMMUNICATION WITH SOUTH AMERICA.—The West Coast of America Telegraph Company and the Central and South American Telegraph Company have issued the following list of tariffs at per word from Great Britain to their various stations:—Salina Cruz 5s., Libertad 5s. 2d., San Juan Del Sur 6s. 2d., Panama 7s. 9d., Buenaventura 8s. 4d., Santa Elena 9s. 5d., Payta 10s., Calloa 11s. 1d., Lima 11d. 1d., Mollendo 12s. 4d., Arequipa 13s. 3d., Arica 12s. 6d., Tacna 12s. 11d., Iquique 12s. 9d., Antofagasta 13s. 4d., Caldera 13s. 9d., Serena 14s. 2d., Coquimbo 14s. 8d., Valparaiso 14s. 8d., Santiago (Chili) 14s. 8d.

SOMETHING LIKE A PATENT.—In looking over the patents recently filed at the Patent Office, we came across one containing, taking the provisional and complete specification together, no less than thirty-eight pages, besides several sheets of drawings. This patent was intended to cover an invention, the object of which was to utilise the water power in cities for actuating turbines, which in turn were to drive dynamos, the current so generated being stored in secondary batteries, and distributed for use by wires as required. Surely it would not take thirty-eight pages to secure the rights to such an invention, if it be one at all. We think there is a little exuberant verbosity or rather scriptology here.

AN INNOVATION IN TELEGRAPHY.—An American contemporary says:—"The Mutual Union Telegraph Company proposes to adopt a new method of doing business by telegraph. The plan is not unlike the telephone system. To illustrate the scheme:—Suppose that A in New York finds in the course of the day that he wishes to settle a certain matter with B, of Chicago. He sends word to the Mutual Union Office to send to B, asking if he can be in the Chicago Office of the Mutual Union at, say, 4 o'clock, in order to talk with A. If the answer is 'Yes,' then the two meet at 4 o'clock, one in Chicago and the other in New York, and two operators ask and answer whatever questions and answers are sent over the wire. In this way there will be no opportunity for delays or misunderstandings."

THE COST OF ELECTRIC LIGHTING.—The correspondent of a provincial paper writes as follows:—"I have recently seen the new building erected by W. Rowntree and Sons, of Westboro', Scarboro'. It is large and handsome and is lighted by about 250 incandescent lights. The power required is supplied by an Otto gas engine of 16 horse-power, which, when working at its full power consumes 690 feet of gas, costing about 2s. 7d. per hour. The engine is a splendid piece of workmanship and is started and in full action in two minutes. The light supplied was very beautiful, soft, pure, and steady, and of course neither heats nor vitiates the air, as gas does to such a lamentable extent. But (there is generally a 'but') the first cost at present is such that it can be adopted by only wealthy firms. The total expense to Messrs. Rowntree of engines, fittings, &c., exceeded £1,200."

ELECTRIC LIGHT EXHIBITION AT BOSTON (AMERICA).—There is a large exhibition of the electric light at the New England Manufacturers' and Mechanics' Institute Fair now being held at Boston, says the *Sanitary Engineer*. Nearly the whole illumination of the building is furnished by the three electric light companies having exhibits there. The Edison Company have about 870 incandescent lamps, most of them being of 16 candle-power, though a few are of 32 candle-power. The New England Weston Company have about 100 arc lamps, known as 2,000 candle-power, 16 being outside in front of the building, 150ft. above the ground (at the top of a 50ft. mast from a 100ft. tower). The same company have about 150 incandescent Maxim lamps of 24 candle-power. The American Electric Company, of New Britain, Conn., have 55 Thomson-Houston arc lamps, known as 2,000 candle-power.

TELEGRAPHIC COMMUNICATION WITH SOUTH AMERICA.—Mr. Alexander Wood, managing director of the Western and Brazilian Telegraph Company, writes as follows to *The Times* of Thursday, November 2:—"Allow me to correct a misapprehension with reference to telegraphic communication between Valparaiso and Europe, which the telegram from Philadelphia in *The Times* of to-day has created. It is therein stated that the opening of the new lines on the west coast of South America 'saves fifteen hours' time between Valparaiso and Europe as compared with the Pernambuco and Lisbon route.' As a matter of fact, however, the average time taken by our system in the transmission of a message between Valparaiso and Europe—*i.e.*, by the Pernambuco and Lisbon route, in conjunction with the cables of the Western and Brazilian Telegraph Company and the Transandine Company's lines, across the Andes, during the last ten days has been about six hours, the shortest time being two hours forty-five minutes. The supposed saving by the new route is, therefore, manifestly impossible."

ELECTRIC LIGHTING AT BIRMINGHAM.—At a special meeting of the Birmingham Town Council held on Tuesday last, the report of the Gas Committee on the question of electric lighting, which was given in our last issue, was adopted, and, on the motion of the Chairman of the Gas Committee, it was unanimously resolved that no application be made by the Council for authority to supply electricity in the borough or in any part of the district either by license, provisional order, or by special Act of Parliament, and that, with respect to the applications for licenses, the Council decline to consent to the same, and with respect to the several applications for provisional orders, that the recommendations of the Gas Committee (Nos. 2, 3, and 4 on page 17 of the report) be approved; also that the Gas Committee be authorised to take all such measures, to employ such professional assistance, and make such conditions with the applicants in the name and on behalf of the Council and, where necessary, under the corporate common seal, as thay may deem necessary or advisable for carrying the said recommendations into effect.

NEW METHOD OF LAYING UNDERGROUND WIRES.—Dr. H. C. Register, of 1,907, Chestnut-street, Philadelphia, has recently invented the following method of laying underground wires:—A watertight longitudinal boxing, of cast or sheet iron, or of wood or clay, is placed in the street under the roadway, and at suitable intervals it is provided with enlargements having manholes leading to the street. On the bottom of the longitudinal box there are two or more longitudinal troughs or compartments, some for telephone and telegraph wires, and the others for electric light wires. Two partitions on the bottom of the longitudinal box extend throughout its entire length, and near the upper edges of these partitions a series of rollers are journaled. In each enlargement at the end of a section, and at suitable intervals in the longitudinal box, is journaled a horizontal shaft

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each carrying a grooved pulley directly above the middle line between the partitions. Endless ropes pass over these pulleys, and the ropes can be moved by turning the shaft by means of hand wheels at the manholes. A carriage rests on the upper edges of the partitions, and can be firmly clamped to the endless rope. In operation the clamping carrier is fastened to the rope at one manhole or enlargement of the box, and one or more wires are attached to the pegs or staples of the carrier. By rotating the shaft the carrier will be carried to the next enlargement or manhole, and the wires will have been carried through the longitudinal box from one station or enlargement to the next, and can easily be placed into one of the compartments of the box. In this manner the wire can be carried through any length of boxing, for when the ends of the wires have arrived at one station—that is, at the end of one section of the boxing—the wires can be attached to the carrier of the next section, and so on. The wires can be removed in a similar manner.

The Conference on Electric Lighting.—On Tuesday last a conference, composed of three members and the clerks of all the vestries and district boards south of the Thames was held at the Vestry Hall, Peckham-road, of which the following account appeared in the *Standard* of Wednesday.—Mr. E. Dresser Rogers, who presided, after referring to the trouble caused by gas and water companies in the past, said the question was whether some line should not be laid down to prevent monopolies in the future.—Mr. A. Middlemass moved, "That it appears to this Conference to be expedient that the control of electric lighting should be in the hands of vestries and district boards, as the local authorities named in the Act, by licenses or provisional order to be obtained in the exercise of their discretion."—Mr. Grummant (Camberwell) seconded.—Mr. F. H. Fowler (Lambeth) thought they ought to first know how the companies proposed to deal with the question.—Mr. S. Chandler (Newington) observed that to light four miles of public thoroughfares by the electric light would cost £2,363 16s. per annum, whereas in the parish in which he was interested they only paid £4,064 19s. 8d. for the lighting by gas of thirty-six miles. He did not think as a conference they were justified in asking the ratepayers to go into an undeveloped scheme.—Mr. A. Scovell (St. Olave's) moved, as an amendment, "That, in the absence of more full and precise information than is at present possessed by the public as to the probable cost of the electric light, the South London vestries and district boards petition the Board of Trade not to sanction a provisional order to any company in South London until the result of a longer experience be before them."—Mr. Purdy (Wandsworth) seconded, and Mr. Palmer (Bermondsey) spoke in support.—Mr. H. J. Smith (Vestry Clerk of Lambeth) held that the Board of Trade did not intend to grant a provisional order to a company or companies who applied to them as a matter of course. On the other hand, if the local anthority applied for a license, they must be prepared to undertake the responsibility of carrying it out at an early period.—Eventually the motion and the amendment were withdrawn; and, on the motion of Mr. Fowler, the conference was adjourned.—The chairman asked the vestey clerks to give the matter their careful consideration in the meantime.

Congress on Electric Units.—We take the following information regarding this congress, which has been sitting for some days past in Paris, from the daily press:—"The congress has separated," says one paper, "after a short speech by M. Cochery. He did not, he said, close the conference, but adjourned it till next year. It had done all the work it had set itself. It had laid down the bases of the work to be effected for the fixing of the unit of resistance, and recommended the methods which seemed to offer the greatest precision. Proposals had also been made to the Telegraph Departments to co-operate with it in the investigation of telegraphic phenomena. It had drawn up a list of questions on the effect of thunderstorms on telegraph and telephone lines. Lastly, it had come to the conclusion, from the investigations hitherto made, that the light given off by melting platina might lead to an absolute standard. It had requested that the experiments might be continued. The conference had asked the French Government to endeavour to secure the realisation of its propositions by persuading different Governments of their utility, importance, and urgency. The French Government, he need not say, would readily acquit itself of this mission. The conference then separated till its next meeting on the first Monday in October, 1883." Another paper says:—"In regard to electrical units it was resolved that at present there is not a sufficient concord of view to enable the numerical value of the 'ohm' in the mercurial column to be definitely fixed, and that all Governments be appealed to by France to encourage further research on the subject. The section for 'Electrical Currents and Lightning Conductors,' resolved that Government should be requested to favour regular and systematic observations of atmospheric electricity; that it is important for the study of storms to be extended to every country; that wires independent of the telegraphic system should be provided for the special study of earth currents; and that, so far as possible, the great subterranean telegraphic lines, particularly those running north and west, should be utilised for the same purpose, observations being instituted on the same day in the various countries. The section for fixing a standard of light expressed the opinion that the light emitted by melting platinum would furnish an absolute standard. It is hoped that the twelve months for which the conference is adjourned will be sufficient for the searches in the various departments in question to be completed."

Central and South American Cable.—We take the following from the Panama *Star and Herald*:—"On Friday, August 4, the steamships 'Silvertown' and 'Retriever' started from Pedro Gonzales Island, in the Bay of Panama, the former ship paying out cable to complete the section between that island and San Juan del Sur, Nicaragua. Mr. Parsoné, general agent of the West Coast of America Telegraph Company, having volunteered to take charge of the temporary hut on Pedro Gonzales Island for the electrical tests, &c., necessary during cable laying, his services were accepted by Mr. R. K. Gray, and, with Messrs. Bailey, Norton, and Phillips, he remained at that island roughing it until Sunday last, when, learning by cable that the work at sea had been completed, they returned in the Pacific Steam Navigation Company's tender 'Taboguilla,' which went to the island to bring them to Panama. The steamship 'Silvertown' returned, as already announced, on the 17th inst., with Mr. R. K. Gray on board, after having successfully completed the section to San Juan del Sur. The final splice of this section was slipped on the 10th, thus completing the telegraphic system of the Central and South American Telegraph Company. A flaw discovered in laying the Pedro Gonzales and San Juan del Sur section was easily removed within twenty-four hours of being discovered, and perfect communication through the whole line was re-established within twenty hours. The electrical tests were so accurately made that they located the flaw within one knot of its

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actual position. The main cable was at once grappled for and picked up in 700 fathoms of water. Reeling in was commenced, and very shortly afterward the defective piece was made good. The cable which was picked up was found within 500 yards of its location on the cable company's charts, a circumstance which proves the wonderful accuracy which must be observed by all concerned in such an extremely scientific and costly work as that which has now been so successfully and happily terminated. The undertaking has been a great one. Now that it has been happily concluded, the few drawbacks which have been encountered having been overcome by foresight and knowledge, and the work having been performed on a coast hitherto almost, if not entirely, unknown to the promoters of cable enterprises, Mr. Robert Kaye Gray, and every one connected with his staff and the vessels, must feel satisfied with the satisfactory results which have attended their labours." As our readers will doubtless remember, we announced the final completion of the cable and the return of most of the staff to England in a recent issue.

Fatal Accident Caused by Electric Light Wires.—We briefly referred in our issue for October 7th to a fatal accident which happened recently in New York, by which a man engaged in repairing electric light wires was killed by the current. The following are some additional particulars of the circumstances attending the accident. It appears that Joseph Stammans, a lineman in the employ of the Brush Electric Illuminating Company, New York, was at work changing wires from an old pole to a new pole. Owing to the increased height of the new pole, it was necessary to lengthen the wire, and in order to do this without interfering with the current of electricity, it was necessary to make connections with the wire by a loop on either side of the crossbar, so that the main wire could be severed after both connections were made. The current passing through the wires was of 80,000 candle-power. The wires are what are known as No. 6 copper wire, an eighth of an inch in diameter, and are thoroughly insulated. To make the loop connections it was necessary to scrape the insulating material from the ends of the wires and connect the naked ends. The instructions given to linemen by the company are never to uncover the positive and negative wires at the same time, but to finish one connection and have the naked wire properly "taped"—that is, covered with rubber tape prepared for the purpose—before attempting to uncover the other wire. Stammans began the work of lengthening out the wires, and had been working about 10 or 15 minutes when Frederick Layman, the assistant foreman of the gang employed in the labour, who was on the side walk at the foot of the pole, noticed that there was something wrong with Stammans. He was clutching both the negative and positive wires of the line, and was hanging limp and apparently lifeless against the wires stretched on the pole. His right leg was thrown over the crossbar, and he swung in mid-air, the wires preventing him from falling to the side walk. Layman summoned other linemen, who climbed the pole and brought Stammans down. He was unconscious, and his ghastly appearance indicated that he had received a terrible electric shock. A physician was summoned, but could do nothing for Stammans, who died within ten minutes after being carried into the station house. The only marks of violence or disfigurement on the body were on the palms of his hands, which were terribly burned and blistered. Stammans was twenty-five years of age, and was married. He had received the shock which caused his death by carelessly allowing his hands to come in contact with the naked ends of both wires of the line. He disobeyed the positive instructions of the foreman, who cautioned him against uncovering both wires at the same time. He had made a half connection on one wire, and before "taping" the naked ends of the wire had removed the insulating material from the other wire, and while making the loop connection with this wire the contact was made, with a fatal result.

Electric Lighting Deputations to the Board of Trade.—Two deputations from the Town Council of Sheffield and the local authorities around Birmingham had interviews with Mr. Chamberlain at the Board of Trade, with reference to the Electric Lighting Act, on Tuesday last. The Birmingham deputation presented resolutions which had been agreed to at a conference of the local authorities of Balsall Heath, Handsworth, Saltley, Aston, and King's Norton, desiring that the Board of Trade be requested to postpone for a reasonable time the granting of any provisional order authorising the supply of electricity by any company or person within any of the districts concerned.—Mr. Chamberlain said that it was impossible to suspend the operation of the Act of Parliament as contemplated by the resolutions, although the Board of Trade fully recognised the difficulties which surrounded the local authorities.—Mr. Ansell said that the local authorities represented had been served with notices of application, or intention to apply, for provisional orders during the ensuing session on the part of three electric lighting companies; and this might make the companies undertakers within the meaning of the Act, and the local authorities affected by the notices would have no chance of obtaining their provisional order, seeing that at the present time they were altogether unprepared to comply with the provisions of the statute, so as to be undertakers themselves.—Mr. Chamberlain said that the matter was pretty much in the hands of local authorities, inasmuch as the Board of Trade depended upon them taking care of their own interests by agreement with the promoting companies before they came to the Board or Trade for their provisional orders, and that the provisional orders would be pretty well agreed to before they were submitted to the Board of Trade.—Mr. Weeks said they wanted to know whether the local boards would have a *locus standi* to appear before the Board of Trade to obtain provisions to protect them.—Mr. Farrar said the Board of Trade had fully recognised that right, and intended to emphasise it in all the circulars which they issued in relation to the matter.—In answer to further observations, Mr. Chamberlain said the Board of Trade could issue more than one provisional order for the same area, but it was not probable that they would. The Electric Lighting Act created no absolute monopoly for the supply of the electric light. In cases where a company had secured a provisional order on a system which became obsolete the local authority must submit their case to the Board of Trade, and it would be dealt with upon its merits, and if they satisfied the Board a second order would be granted. In the event of a second application, the Board would see how far the existing undertakers had performed their obligations, and if it was found that they had faithfully performed them and expended a large sum of money, their interests would not be overlooked. As to the suggestion of the deputation for confining electric companies to restricted areas, he believed from the experiments which had been made it would be absolutely impossible to light any but closely populated areas at a profit.—The deputation then withdrew. The deputation from Sheffield held their consultation with Mr. Chamberlain in private.

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THE LIFE OF JAMES CLERK MAXWELL.*

When the sad news of the death of Clerk Maxwell was first made known to the scientific world, men could hardly realise the loss sustained, but as time goes on we begin to understand more and more how great was that loss. The work before us is of extreme interest, and will enable many who knew Maxwell only from his writings to see that his friends have to mourn not only the man of science but a true and simple-hearted gentleman. We shall attempt to give some idea of the contents of this book, and not to build up any brief connected history of Maxwell's life from it, believing that any such short account must necessarily be a very inadequate representation of his life. Professor L. Campbell gives the chief credit of the work to Professor Garnett, who had the lion's share of the labour of collecting materials for the whole biography, and who mainly composed the second part of the book. Professor Campbell's work, however, has also been admirably done, and we have no doubt the collective labours of the joint authors will be highly appreciated.

The work commences by giving the history of Maxwell's birth and parentage. He was born in Edinburgh in 1831, his father being John Clerk Maxwell, one of the Clerks of Penicuik, in Midlothian, his mother, Frances, the daughter of R. H. Cay, Esq., of N. Charlton, Northumberland. John Clerk Maxwell was talented and slightly eccentric. The mother is described as a "good and pious (not bigoted) Episcopalian," her chief bent, "like that of her husband, practical and matter of fact." The note at the end of Chapter I. refers to the Clerks of Penicuik and the Maxwells of Middlebie. The childhood of Maxwell was spent at Glenlair, near the village of Kirkpatrick Durham, and this childhood will form an interesting study not only to those who love science as Clerk Maxwell loved it, but who have children and are interested in watching the development of mind. Young Maxwell was eager to learn the why and the wherefore. Not satisfied with seeing the outside or being told the result, he wanted to know "how it does." His constant question was, "What's the go o' that?" "What does it do?" Nor was he content with a vague answer, but would reiterate, "But what's the particular go of it?" Maxwell, in fact, was filled with a desire to look behind the surface, and find the cause for the particular effect. After the death of his mother a tutor was provided, but the experiment was not a success.

The third chapter of the book describes his entrance into school life at Edinburgh Academy.

What happened in the interval after the first lesson (in the space behind the second class room) is best indicated in the words of the Psalmist, "They came about me like bees."

"Who made those shoes?" was the first question; but it was never easy to get a direct answer from Maxwell, least of all on compulsion. Brought thus to bay, he had recourse to his natural weapon, irony. His answer was soon ready, and his tormenters might make of it what they list. In the broadest tones of his Corsock *patois* he replied to one of them:—

> Did ye ken 'twas a man,
> And he lived in a house,
> In whilk was a mouse.

"He returned to Heriot-row that afternoon with his tunic in rags and 'wanting' the skirt, his neat frill rumpled and torn, and showing not the smallest sign of irritation." His father lived now at Glenlair, now at Edinburgh. The love and friendship between the young and the old was great and true—the young boy writing amusing letters to enliven his father at Glenlair. It was while at Edinburgh Academy that Professor Campbell first became acquainted with Maxwell. The one lived at 27, the other at 31, Heriot-row. The chapter ends with an account of the holidays. At first young Maxwell did not shine in school work, he got the nickname of "Dafty," but ere his school days were ended all those brought into contact with him saw the germs of great things. Referring to the mathematical teacher, Professor Campbell says:—"Mr. Gloag was a man who combined a real gift for teaching with certain humorous pecularities of tone and manner. He was sometimes impatient, but had a kind heart, and we liked him all the better because we mimicked him. Old academicians still delight in talking of him. He never allowed us to miss a step in any proof, and made us do many 'deductions,' which we puzzled out entirely without help." At this time Maxwell commenced rhyming, and gained, in 1845, at the age of fourteen, the prize for English verse, in addition to the Mathematical Medal. Before another year—that is, before he was fifteen years old—a paper "On the Description of Oval Curves and those having a Plurality of Foci," was read before the Royal Society of Edinburgh, the production of young Maxwell. After leaving the Academy Maxwell spent three years at Edinburgh University, not going to Cambridge till 1850. This time was a time of development. His originality had free play, and he gave full scope to his experimental tastes. His letters are characteristic—they are full of thought, yet frequently rushing off at a tangent—describing this or that just as the fancy seizes him, and full of indications of high animal spirits. We cannot help quoting from a letter to Campbell:—

"I have regularly set up shop now above the washhouse at the gate, in a garret. I have an old door set on two barrels and two chairs, of which one is safe, and a skylight above which will slide up and down.

"On the door (or table) there is a lot of bowls, jugs, plates, jam pigs, &c., containing water, salt, soda, sulphuric acid, blue vitrol, plumbago ore, also broken glass, iron and copper wire, copper and zinc plate, beeswax, sealing wax, clay, rosin, charcoal, a lens, a Smee's galvanic apparatus, and a countless variety of little beetles, spiders, and woodlice which fall into the different liquids and poison themselves. I intend to get up some more galvanism in jam pigs, so I am experimenting on the best methods of electrotyping. First, I thought a beetle was a good conductor, so I embedded one in wax (not at all cruel, because I slew him in boiling water, in which he never kicked), leaving his back out, but he would not do. Then I took a cast of him in sealing wax, and pressed wax into the hollow, and black leaded it with a brush, but neither would that do. So at last I took my fingers and rubbed it, which I find the best way to use the black lead. Then it coppered famously. . . ." Further on, in the same letter, he speaks of a fault in Poisson's works which we fancy is to be found in many another author. Maxwell says:—"Of course he never stoops to give a particular example or even class of them." At Chapter VI. we come to undergraduate life at Cambridge. The book here, as elsewhere, contains a number of Maxwell's letters, which give a better idea of the man than could be given by any other means. Professor Campbell's connecting narrative is, however, worthy of careful reading, as not only does he depict Maxwell's life, but adds certain reflections which are of great value. He says:—"Men of genius are often represented by themselves and others as owing little or nothing to their education. This certainly was not true of Maxwell, whose receptivity was only less than his originality. He laid a strong retentive grasp on all that was given him, and set his own stamp on it in return. Both what was good and what was defective in his early training had left a lasting impress on him, and it was by no means an indifferent circumstance that in the maturity of his powers he entered Trinity College, Cambridge, at an advanced period of the long Mastership of Whewell." And again:—"The six months from December, 1852, to June, 1853, were a time of great and varied mental activity. When the Tripos work became most exacting, he seemed to have the most spare energy. No part of the rich mental life of Trinity failed to touch and stimulate him, from the Moral Philosophy of the Master to undergraduate discourses on whist and chess. When most burdened with analytical book work he yearned the more deeply after comprehensive views of nature and life, and found refreshment in metaphysical discussion, and occasionally in theological controversy. Even the 'occult' sciences, in the contemporary shapes of electrobiology and table turning, had their share of ironical atten-

* *The Life of James Clerk Maxwell, with a Selection from his Correspondence and Occasional Writings, and a Sketch of his Contributions to Science.* By Professor L. CAMPBELL, M.A., LL.D., and Professor W. GARNETT, M.A. [Macmillan and Co.]

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tion." His assiduous attention to his studies brought him physically below par, and in 1853, while staying at the Rev. C. B. Tayler's, at Otley, in Suffolk, he suffered from a severe attack of illness. In January, 1854, he came out as second wrangler, Routh being first, but was bracketed with Routh as first Smith's prizeman. His further stay at Cambridge, his election to a Fellowship, the work of this period, his aspirations, and his essays are described in Chapters VII. and VIII. A change in his life came in 1856, his father dying suddenly in April of that year. Besides the claims the estate had upon his time, he entered upon his professional duties at Aberdeen. Then comes the time of his marriage, the supression of the Professorship at the Marischal College, and his withdrawal from opposition to Professor Tait, when Professor J. D. Forbes resigned his chair at Edinburgh. We all know the early history of ocean telegraphy, how failure succeeded failure; but still bold hearts, willing hands, and deep pockets continued the work till success was achieved. That the workers, and among them must be reckoned Maxwell, who had for long been studying the problems of electricity, whose papers had already made their mark, and whose interest in the subject was known to be deep—the workers, we say, never thought of failure, each mishap was an incentive to success. Maxwell, in one of those poetical effusions of his, after describing the delight at receiving signals, the wail of despair at something going wrong, concludes:—

IV.

2 (U).
There let us leave it for fishes to see.
2 (U).
They'll see lots of cables ere long,
For we'll twine, twine, twine,
And spin a new cable, and try it again,
And settle our bargains of cotton and grain
With a line, line, line,
A line that will never go wrong.

Now Maxwell begins to take rank as one of the giants of science. He goes to King's College, London, then to Cambridge, with, however, a few years between, which were spent at Glenlair. It is difficult to withhold a sort of admiration here, when again and again the intense homliness of the man is described. Family affection is a trait which is as characteristic of Maxwell as is his originality in science.

The great work on "Electricity and Magnetism," the smaller but important one on Heat, were published while Maxwell was at Cambridge, although mostly prepared while at Glenlair. His influence at Cambridge it is difficult to estimate. The results of that influence are only commencing, and for years to come the germs which Maxwell planted will expand and fructify. For this part of Maxwell's life we must refer to the book. Near the conclusion of the first part of the volume we find the following estimate of Maxwell's character:—"In these reminiscences I have purposely abstained as much as possible from comment. But in concluding this portion of the present work, I may be permitted to record a very few general observations or impressions. The leading note of Maxwell's character is a grand simplicity. But in attempting to analyse it we find a complex of qualities which exist separately in smaller men. Extraordinary gentleness is combined with keen penetration, wonderful activity, with a no less wonderful repose, personal humility and modesty, with intellectual scorn. His deep reserve in common intercourse was commensurate with the fulness of his occasional outpourings to those he loved. His tenderness for all living things was deep and instinctive; from earliest childhood he could not hurt a fly. Not less instinctive was the sense of equality amongst all human beings which underlay the plainness of his address. But, on the other hand, his respect for the actual order of the world, and for the wisdom of the past, was at least as steadfast as his faith in progress; while fearless in speculation, he was strongly Conservative in practice.

"In his intellectual faculties there was also a balance of powers which are often opposed. His imagination was in the highest sense concrete, grasping the actual reality, and not only the relations of things. No one was ever more impatient of mere abstractions. Yet few have had so firm a hold upon ideas. Once more, while he was continually striving to reduce to greater definiteness men's conceptions of leading physical laws, he seemed habitually to live in a sort of mystical communion with the infinite."

Other extracts we should like to make, but our space is almost exhausted, and the extracts we have given show the character of the book. The biography has been written by old friends of Maxwell, men who have known him intimately in the various phases of his all too short but brilliant career. We can only recommend our readers to turn to the work itself to read their opinions of their friend. The second part of the book discusses Maxwell's contributions to science, while the third and last part gives a number of his poems. These add greatly to the interest of the book, but must by us be passed over in silence, except that, perhaps, we may be allowed to quote one verse from a paradoxical ode:—

Great Principal of all we see,
Unending continuity,
By Thee are all our angles sweetly rounded,
By Thee are our misfits adjusted,
And as I still in Thee have trusted,
So trusting, let me never be confounded.

The idea herein expressed is shared by many searchers and seekers into the mysteries of science.

CURRENT, FORCE, AND ENERGY.

BY JOHN T. SPRAGUE.

Some time ago, as a result of a discussion, I made the statement that potential or electromotive force was simply an expression for $\sqrt{\text{energy}}$. This was objected to, both by Professor Baynes and Mr. FitzGerald, but I was compelled to leave the matter for the time. I now propose to maintain my thesis and to prove another statement of mine differing from accepted doctrines, viz., that the laws of current and conduction are the same for electricity and for water. With this object I will examine separately the different elements of the problems.

Ohm's Laws.—These laws or formulæ are universally employed by electricians, and they fully explain and enable us to calculate every function of the electric current, when properly understood; but if not clearly understood they may lead to misconceptions. These formulæ are not, however, confined to electricity, for if examined they will be found to express simply the common fundamental mechanical laws. The relations established by Ohm's laws between electromotive force, resistance, and the current and its work, are simply the well-known laws of mechanics, or the relations between force, such as gravity, weight, and velocity; and the laws themselves are merely mathematical expressions. Invaluable in dealing with the modes of operation, they only delude us if we regard them as facts, and do not clearly trace out the reasons why they are valuable. The importance of these considerations will be evident if we clearly see that, in consequence of misunderstanding this, and of the converting the mathematical formulæ, which are really nothing but mental tools (apparatus for mechanical thinking in some sense), into actual facts and theories, electricians have actually been led into a complete error as to the nature of the electric constants. To show that I am not about to fight a man of straw, I quote a passage from a lecture delivered at Glasgow by that eminent practical and theoretical electrician, Dr. Siemens, on the 14th March, 1878. Speaking of the possibility of utilising natural forces, such as waterfalls at a distance, he said:—"My critics have, however, fallen into the error of overlooking the fact that half a unit resistance is the same for a circuit capable of working one lamp as it is for working 100 or 1,000 lamps. *Electricity is not conducted upon the conditions appertaining to a pipe conveying a ponderable fluid,* the resistance of which increases with the square of the velocity of flow; it is, on the contrary, a matter of indifference what amount of energy is transmitted through an electric conductor; the only limit is imposed by the fact that, in transmitting electric energy, the conductor itself retains a certain amount proportional to that transmitted, which makes its appearance therein in the form

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of heat." We have here two distinct statements—1st, that in electricity a resistance is the same to all currents transmitted; 2nd, the sentence italicised, that currents of electricity, and currents of water, depend on different laws. Probably every electrician then, and most of them now, would endorse those statements. I dealt with them at the time, in the pages of *The Electrician* and the *English Mechanic*, and will do so now fully, because the clearing away of errors is doing good service to science and to your readers. The first I will deal with under its proper head, "Resistance," but the direct result of the principles now to be investigated will be to prove that *water in pipes and electricity in wires are conducted upon identical conditions*.

The fundamental expression of *Ohm's laws* is $\frac{E}{R} = C$, which means force divided by resistance defines the current, or rate of flow.

It follows that any two of the three elements, E, R, and C, being known, we can calculate the third thus:—

Current. $E \div R = C$. Force and resistance being known.

Electromotive Force. $C \times R = E$. Current and resistance being known.

Resistance. $E \div C = R$. Thus, with any cells the force of which is known (as most are) in volts, dividing this by the current in amperes, gives us the total resistance; and if the external resistance is known, by deducting this we get the internal resistance of the battery.

Energy $= C^2$, the square of current, resistance remaining unchanged. According to these relations, C varies as E; energy, as mechanical work or heat, varies as E^2. Hence, different formulæ give it as $C^2 \times R$, the unit of which is the joulad, or $E \times C$, which formulates the volt-ampere, proposed to be called the watt, which is of the same value as the joulad. The very first point to be considered is whether these symbols have any reality behind them. Are they mere mathematical abstractions, simple tools of thought, or are they concrete realities? This is really a very serious question, because these scientific formulæ are now so extensively employed and so completely relied upon that they acquire a kind of actuality. It will be convenient to examine the question while studying Ohm's formulæ as a whole, rather than under the separate heads of force and resistance. Let us see what idea we can form of electromotive force. A force tending to set electricity in motion; or, to use a better phrase, to set up that motion which we call electricity. Here it will be seen we have at once two considerations presented to us: an effect, the motion produced; a cause, the force producing the motion. Of these the first, the motion, is of necessity an actual fact, though we may hold different ideas as to what is the thing. But does the *cause*—the *force* exist, that is to say as a special force? There are actual forces having real existence, such as the various attractions of which we may take gravitation as the type; these are, so to speak, self existent—we know not their causes. But there are other agencies which we call forces, yet which have no actual existence. They are really transfers of energy, and are forces only in the mathematical sense.

Any agency may be called a force which is capable of setting up motion, or altering the conditions of motion in a mass of matter. Thus, if we take a ball of lead and let it fall, motion is imparted to it by gravitation. We may push the same ball of lead along a table, or by muscular energy hurl it to a distance; we may strike it, as a cricket ball is put in motion, by a percussive blow; or we may, by aid of a gun, set it in motion by means of compressed air or by the explosion of gunpowder. In all these cases motion is produced, and we may call the agency in each case a "force." We may even embody all these agencies in one expression, and attribute the motion generated to the action of a "Mechanico-motive Force," the intensity of which we can measure by the amount of motion produced.

Such an expression would be correct mathematically; in fact, the dyne is strictly a unit of "Mechanico-motive Force." But it has no actual existence, it is simply a convenient mathematical expression. A tool, not an agent. Is it the same with electromotive force?

Electromotive Force.—When we dissolve zinc in a battery this force makes its appearance. It is said by some to be due to the contact of the two dissimilar metals. But one thing is certain, this force can do no work unless it is maintained by an equivalent supply of energy, and as a matter of fact easily proved, the degree of electromotive force produced is measurable in terms of the energy transformed in its generation, which is measurable by the heat set free in the chemical combination.

But if we expose the junctions of two different metals to heat, we find electromotive force set up in degrees depending (1) upon some inherent property of the metals (which has an appearance at all events of supporting the contact theory of its origin), and (2) upon the different temperature produced, which means in fact the quantity of energy which can be thrown into the circuit.

Similar results are found when we examine the E.M.F. set up by dynamo machines. It bears a definite relation to the energy expended. We find also that though electromotive force is constantly acting upon the circuit, it has no accelerating action. We are therefore forced to the conclusion that it has no actual existence, but is due to conversion of energy. Therefore, E, in Ohm's formula, is simply an expression, valuable for calculations, but symbolising not a thing, but a value, a quantity of energy applied in a specific mode to produce a definite molecular disturbance in a conductor and a propagation of electrical action. Presently it will be seen that E represents the *square root of the energy* involved; that just as work $= E^2$, the square of force, so force $= \sqrt{\text{work}}$, the square root of energy. This really is an inevitable result of the law of the conservation of energy, and yet, strangely enough, when I first stated it in the pages of *The Electrician*, it was condemned by several eminent mathematical electricians. To trace and prove it we must now turn to mechanical forces.

Laws of Falling Bodies.—Gravity, as an accelerating force, generates a velocity, V, of 32·2 feet per second, producing, therefore, an actual motion of 16·1 feet per second. For present purposes it will be convenient to use the round numbers 16 and 32. From this it is evident that a vertical pipe of one inch section, open at the bottom, and supplied from a reservoir 16 feet high, would deliver a stream of water of 16 feet per second, neglecting any effect of friction. But this would not be the proper current supplied under unit head of 16 feet, as the water is not all under the full head, and the pipe holds it back. To have the true "head of water," and its proper velocity, we must have a vertical supply so large in section as to allow the water to descend in it with very small "velocity," though it will have, of course, the full "momentum," which is transferred to and retained by the water actually issuing. If in the side of this supply pipe or reservoir we have an opening of one inch circular, the water would issue from it with a velocity of 32 feet per second (ignoring any effects due to the nature of the opening). That is, it would deliver a stream of 32ft. long and one circular inch in area, or 302 cubic inches, which is 1·08 gallon per second. We can extend this with a general view of the force, energy, and water currents due to gravity, or to any pressure which generates the same velocities as gravity. For this purpose I have arranged the table of "Force of Gravity and Velocity," which exhibits many mechanical principles besides those to be considered now. Col. I. shows the times in seconds, and

Time in seconds.	Velocity.		Space traversed and energy acquired.				$\sqrt{\text{energy}}$ $\sqrt{\text{ratio}}$ = time.
	+ per second.	Total.	Per second. Fresh.		Total.	÷ 16 gives ratio to unit.	
I.	II.	III.	IV.	V.	VI.	VII.	VIII.
1	32	32	16	16	16	1	1
2	32	64	32 + 16 =	48	64	4	2
3	32	96	64 + 16 =	80	144	9	3
4	32	128	96 + 16 =	112	256	16	4
5	32	160	128 + 16 =	144	400	25	5
		momentum V × mass.	Energy $\frac{V^2 \times \text{mass}}{2}$		Head of water is energy.	Square of time.	Force M.

velocity being as time, it shows also the unit forces acting,

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as seen by cols. II. and III., which latter give the momentum acquired. Col. IV. shows how, in each second, there is the space traversed due to the velocity acquired in the previous second + that due to the acting force. Col. V. gives the total space traversed, which, if multiplied by pounds moving, gives the energy in foot pounds due to the motion, in accordance with the formula $V^2 \times \text{mass} \div 2$; for if the ratio to unit in col. VII. is multiplied by unit velocity or 32, half the product is col. VI. This energy is what used to be called *vis viva*, and in hydraulics the same figure, being the height to be fallen, is called head of water. Divided by 16, the unit, it gives us col. VII., which, therefore, represents units of energy (or head of water). It shows also that this is as the square of time, and time being the same value as force acting, we have the evidence that energy is as the square of force, which agrees with the electrical formula that energy is as E^2. Therefore we get col. VIII, which shows many things. Its primary object is to give us the "square root of the head of water," for purposes to be explained presently. Therefore (as 16 is our unit head) this is expressed in terms of square root of the unit heads in col. VII.; but, by reason of the linking of all these matters, this is the same thing as the time, and, therefore, as the forces acting. This column thus explained is, therefore, *Force*, and we may symbolise it by M, as electrical force is symbolised by E.

Mechanico-motive Force.—This, the force of gravity, or of any other generator of motion, is now reduced to the same conditions as electromotive force. We express it as M, and want to use it in dealing with water currents as E is used in dealing with electric currents. In hydraulics the *apparent* force, "head of water," is not (as many might suppose from its use in formulæ) the *true* force. That to which current is due varies not as the head, but as the square root of the head, and M therefore expresses the unit values of the several forces due to different heads in that ratio. But the *energy carried by a current of water* varies as the square of the velocity, or actually as the height fallen—the head itself, expressed in feet, col. VI., or in units, col. VII. In water, as in electric currents, *current* is as force, *energy* is as square of current or of force. It must needs be so, and it becomes obvious when we take the natural point of view. It is completely hidden from the scholastic point of view. The difference is that the mathematician makes force the central point and all the rest consequences, and in doing this he gives vitality to a phantom of his own creation. The natural agent is *energy*; it is that, in its various forms, which effects all natural processes. *Force* is a formula, a tool, and it represents energy by its square root for very important uses. Seeing this, all the difficulty is dispersed which many students find in understanding that the work of a current is as the square of the current, or of the force; it is a simple part of nature as to measured currents, friction, resistance, &c.; it results from the plan, adopted for convenience of calculation, of expressing the cause of currents (head of water, energy mechanical or electrical) in *terms proportional to the currents instead of to the squares of them.*

No doubt many readers will find some difficulty in at once realising all the relations of head of water, square root of head, and of unit head. I will, therefore, transfer the same ideas to something more readily appreciated, though useless for the working out of the principles exactly.

Current is really rate, velocity of a unit, *i.e., speed.* We may, therefore, connect the idea of "current" to the motion of a steam ship—of a railway train. Such ship or train would be the unit, and its motion, in miles per hour, would be the "current." The resistances to motion are compound, and do not all vary in the same way, so that the exact ratio of work to speed cannot be fixed exactly, but it is certain that the real law, subject only to some small variation, is that the work done in propulsion, that is, in producing current, varies as the square of the speed—the general law of mechanics.

To the ordinary mind seeking an idea of a force, the steam engine expressed in horse-power would probably seem the most natural. But to the mathematician a horse-power is not a unit force, nor "a force" at all; it does not generate "acceleration." A horse-power is an expression of *energy*, not of *force*; it means 33,000 foot-pounds per minute, and foot-pounds are units of energy.

What results? We can express horse-power in terms of force, but to do so we must take their square root, exactly as with heads of water.

If 1 horse-power produces a speed of ship or train of one mile per hour, it will require four to produce two miles, and nine to produce three miles speed. We have then, just as in the former reasoning,

Current or speeds	1	2	3	4	5	6
Horse-power or energy......	1	4	9	16	25	36
Force = $\sqrt{\text{horse-power}}$ ...	1	2	3	4	5	6

The conditions are identical with those of water currents and electricity.

Conducting Capacity.—To transmit either electrical or water current we require a conductor, and water pipes and electrical wires are identical in mechanical relations—that is, their capacities vary in the same ratios. The capacity (disregarding for the present resistance or friction) is simply as the *sectional area*—that is to say, as the square of the diameter. This latter, d^2, is required for calculations in practical work; but in considering principles it only confuses the mind. It is the area alone that we should think of. To do so we should regard it as constituted of unit areas, such as the circular inch for pipes, and the circular "mil," or $\frac{1}{1000}$th of an inch for wires; circular, not square inch, as area is usually expressed, because pipes and wires have a circular section, and, therefore, the unit conductor multiplies truly into the practical conductor. Let us call unit area A, which some further considerations will convert into unit of conducting capacity.

It is evident that under the conditions of the first paragraph on "Laws of Falling Bodies," unit area delivers unit current = 1 C = 1 gallon, and that as we increase A we shall have C increase in the same ratio; but we know also that C in similarly related to force. Doubling the square root of head (that is, making 16 into 64ft.) we double current, and make C = 2. Precisely the same conditions hold in the electric current. Therefore, we can say that in both current varies as force and as conducting capacity, and we can formulate them side by side,

Water...... $C = M \times A$.
Electricity $C = E \times A$.

In order to define the true conducting capacity of an actual conductor, we must consider the resistance to the action. We must also add the definition of length to that of area before we can define a unit conductor, pipe, or wire.

THE MUNICH EXHIBITION.—III.

Methinks it would be a difficult task to write correctly and yet write for the *Saturday Review.* Fortunately for the writers in such papers the majority of readers do not know what is true and what is erroneous, or a large number of pens would soon be idle, and the *Saturday Review* would be known no more. Last week we read in this pre-eminently readable paper an article upon the International Electric Exhibition at Munich, which, among other equally astounding assertions, stated that "The fact is that there is only one engine in the Glaspalaste which can even be called good, and that is a well-designed and well-made semi-portable compound engine by Messrs. Ruston, Proctor, and Co., of Lincoln, *a firm which is comparatively little known in England.*" We have italicised the words which convey the new information. We had previously laboured under the impression that the firm of Messrs. Ruston, Proctor, and Co. was one of the best known firms in England. We quite agree with the statement that the engine of this firm used by the Edison people was well designed and well made, that is only what we should expect from a firm whose position is upon a level with any other that can be mentioned, and is recognised in England as being so. To whom do we look for good engines if not to the firm mentioned, to Marshall and Sons, to Ransomes and Co., and one or two others of like calibre? England is proud of these

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firms, and is far from ignoring any one of them at home. There are other sentences in our contemporary's article which must be taken *cum grano salis.*

It may be well to mention here that the larger part of the conducting wires used at Munich was placed at the service of the Committee by the manufacturers of the Berthoud and Borel system of cables. These cables are entirely covered by a tube of lead, and so have the very great advantage of being watertight. A good deal has been said and written about wires encased in a fireproof covering, but practical electricians tell us that their difficulties arise generally

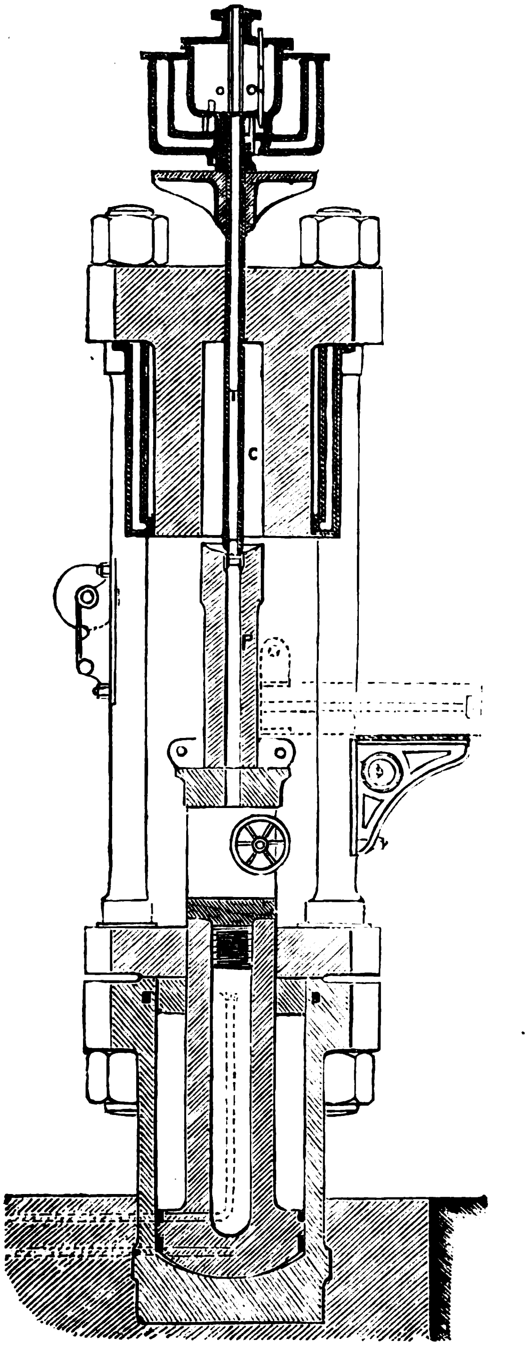

Fig. 1.—Berthoud and Borel's Machine.

from damp, from water and not from fire. The latter is a bugbear which has no home except in the breasts of managers of insurance companies, and has no hope except in the hands of charlatans. Specimens of the Berthoud and Borel cable have recently been sent to us by the Electrical Trading Company, who have been appointed the agents for Great Britain. The conductor of these cables is, as is usual, of one or a number of copper wires, and is covered with servings of cotton wrapped in opposite directions. The wire thus covered is dipped into a bath of insulating material at the high temperature of nearly 400deg. F. The insulating material is said to be paraffin and colophane. It makes a man feel how ignorant he is, especially when he has undertaken to write a report, to have to admit that the electrical or insulating properties of colophane were previously unknown to him. Watts's "Dictionary" tells that it is "a constituent of icica rosin, containing, according to Scribe, $C^{20} H^{30} O^{2}$. It is yellow, amorphous, easily soluble in alcohol, melts above 100deg. C, is insoluble in aqueous alkalis, and reacts neutral." Afterwards we are told that it is a synonym of "colophony," "rosin," &c. Now, had the word rosin been used, the ordinary reader would have understood at once the composition of this insulating compound. This process gets rid of all the water there may be in the cotton covering, and the insulation is said to be good. The conductor thus insulated is encased in a lead tube. The method of doing this is simple. The figure shows a section of the apparatus employed.

A lead ingot is placed in the hollow chamber C, which it fills completely, except that it has an axial hole equal in diameter to the exterior diameter of a tube, T. The piston P, of diameter equal to that of the ingot, is forced upwards by an hydraulic press. The tube T receives the conductor from the bath of melted insulating material placed above it. The wire covered with cotton and rolled on its reel is plunged into the bath of paraffin and rosin. It is then slowly unrolled and passes into the tube T, where it receives a second charge of melted insulating compound. The piston P compresses the lead ingot, which can escape only through the narrow annular space between the exterior part of the tube T and the diameter of the hole which traverses the piston. It is thus squirted into a tube which exactly covers the cable.

These lead-covered conductors are made of various types, containing from 1 to 36 conducting wires, with single or double lead coating, and weighing from 177lb. to 720lb. per mile. The following table gives some of the particulars of conductors with a double lead covering:—

No.					Weight in lbs. per mile.
1	7 conductors,	7 wires,	·0195 inch	...	3116
2	3 ,,	7 ,,	·0195 ,,	...	1908
4	7 ,,	1 ,,	·0351 ,,	...	2150
5	3 ,,	1 ,,	·0351 ,,	...	1293
7	2 ,,	1 ,,	·0273 ,,	...	913
8	6 ,,	1 ,,	·0273 ,,	...	1547
9	14 ,,	1 ,,	·0273 ,,	...	2479
10	14 ,,	3 ,,	·0195 ,,	...	2992
11	2 ,,	3 ,,	·0195 ,,	...	1009
18	1 ,,	36 ,,	·0585 ,,	...	7260
19	1 ,,	12 ,,	·039 ,,	...	2131
20	1 ,,	19 ,,	·039 ,,	...	2772
26	7 ,,	7 ,,	·0273 ,,	...	4105
32	1 ,,	19 ,,	·0585 ,,	...	5029
33	5 ,,	1 ,,	·0351 ,,	...	1771
34	6 ,,	1 ,,	·0351 ,,	...	1834
35	8 ,,	1 ,,	·0351 ,,	...	2379
36	4 ,,	7 ,,	·0195 ,,	...	2401
38	11 ,,	1 ,,	·0273 ,,	...	2585
39	15 ,,	1 ,,	·0273 ,,	...	3187
41	3 ,,	3 ,,	·0351 ,,	...	2337
42	26 ,,	1 ,,	·0273 ,,	...	6021
46	9 ,,	1 ,,	·0273 ,,	...	2656
48	4 ,,	1 ,,	·0351 ,,	...	1381
61	28 ,,	3 ,,	·0195 ,,	...	6109

We have already referred to the special features of the Edison exhibits, and shall now direct attention to that of Crompton and Co. This firm exhibited two Bürgin machines, one of which was used to supply the current to three arc lamps, the other supplied the current to Maxim or Swan incandescent lamps. The Bürgin machines were of the usual type, but progress was shown in the arc and incandescent lamps. Taking them in order, the improvement in the arc lamps is in a focussing arrangement. The method of carrying it out will easily be seen from the diagram. A flexible wire cord is placed and fastened in a groove in the rack-rod, which carries the upper carbon, and passed up the groove over the pullies $Y\ Y_1$, then down the side tube, and over other pullies $Y_2\ Y_3\ Y_4$ to Z, where it is fixed. The last pulley Y_4 is

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pivoted on a frame carrying the lower carbon S. It will be seen that when the upper carbon holder D D rises the lower carbon holder S falls, and when the former falls the latter rises. A flexible connection from the tube P makes the required contact with the lower carbon. The feed arrangement is as follows:—The main current passes through the cores of thick wire A A, causing the armature C to be attracted. This attraction raises the clockwork, and consequently the rack rod D D, causing the arc to be struck. A portion only of the current passes through the shunt coils B B, attracting the armature E attached to the brake F. When this brake is raised the train of wheels is liberated,

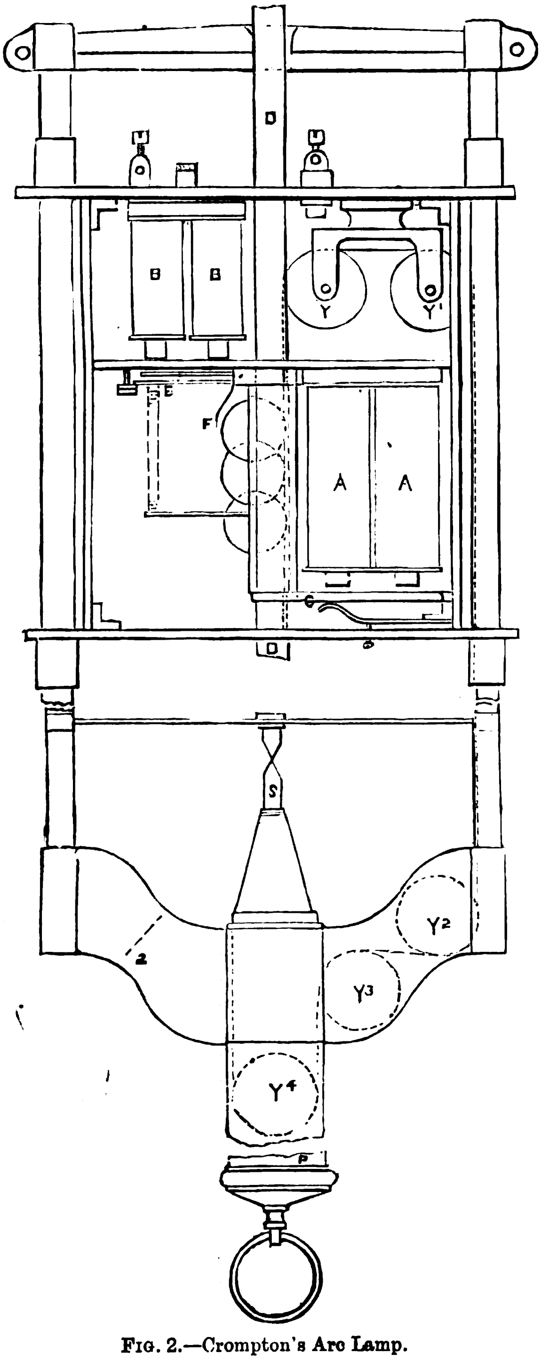


Fig. 2.—Crompton's Arc Lamp.

and the lamp feeds. We understand that other improvements have been made during and since the Munich Exhibition, but we have now to chronicle only those improvements which existed in the lamps exhibited. One of these lamps was used to light up the chapel, and so arranged as to throw a flood of light over the kneeling figure of the cardinal in front of the altar rails. The chapel and its "dim religious light," together with the "matin music," was one of the sights of the Exhibition, causing the visitors to pause,

Neath a canopy, wherein
Purple, pearl, and gold are blended.

CORRESPONDENCE.

CHARGING SECONDARY BATTERIES.

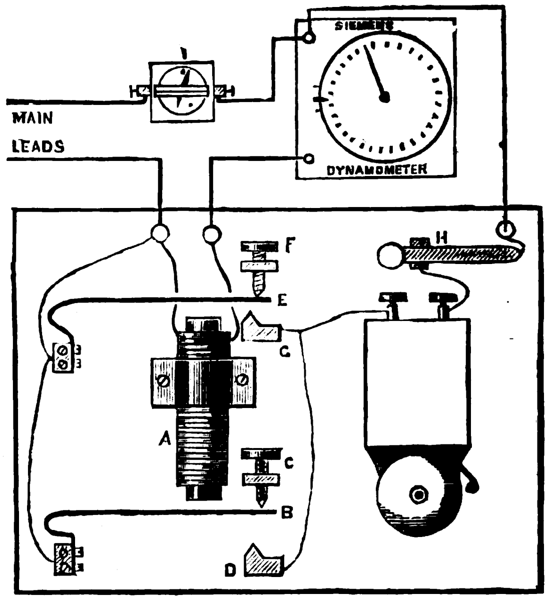
TO THE EDITOR OF THE ELECTRICIAN.

Sir: In charging secondary batteries it frequently happens that a slight diminution of the speed of the engine, or other cause, will produce a reversal of the current, not only running down the battery, but also heating the dynamo to an injurious extent.

The enclosed sketch of the device we use for giving warning of reversal or variation of current beyond certain limits may be useful to some of your readers who are engaged in the above branch of electricity.

The electro-magnet A, wound with some thirty turns of No. 12 wire, is in the main circuit. When the current has been started and brought to its proper strength the steel spring B is brought up to the stop C by hand and held there by the magnet. C is then screwed down until the magnet only just counteracts the spring. The upper stop F is next adjusted until the magnet almost pulls down the spring E, and the switch H is turned on.

Should the current weaken, the magnet can no longer hold back B, which then makes contact with D, and the bell is thus made a shunt on the dynamometer and electro-magnet,



and rings until the current is increased and the spring replaced.

Should the current, on the other hand, get too strong, the magnet will then overcome the spring of E, and pull it into contact with C, thus also ringing the bell. Prior to reversal, the current naturally falls to zero, loosing B, and giving warning even before reversal takes place.

Should the engine stop altogether the batteries would then discharge through the dynamo, and give current to ring the bell. We always have a compass, I, wound with three or four turns of wire, in the main circuit; and a glance at this will show whether the bell has rung for reversal or no.

A modification of the above might be made to cut off the current altogether when about to reverse by passing the main current through B and C, and adjusting the spring so as only to leave the magnet and break the circuit. When the current falls very much, it might, at the same time, ring a bell by a battery.

It may be arranged that too much current rings one bell and too little another of a different tone.

Reversal of current would then ring both, as the decrease before would set one going, and the increase after would pull down the top spring and start the other.—Yours, &c.,

C. W. S. Crawley.

School of Electrical Engineering, 12, Princes-street, Hanover-square.

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ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As your columns are open to all matters connected with electric lighting, I take the liberty of giving you an explanation of the state of affairs at St. Enoch's Station, Glasgow, which I believe was the first railway station lighted by electricity in Great Britain.

Some three years ago (acting for the British Electric Light Company) I succeeded in inducing the directors of the Glasgow and South Western Railway Company to adopt electric lighting, and, as they had an engine upon the premises constructed for driving the machinery of the laundry of their hotel, it was arranged that this engine should be used for the purpose of driving the Gramme machines.

I pointed out at the onset to one of the directors of the railway company that the engine was not only sufficiently powerful to drive the machines, or even double the number, but that I feared the engine main-driving belt would slip upon its countershaft pulley, when I was met with the remark that the arrangement would be but a temporary one, and if the light gave a fair degree of satisfaction the company would erect a special engine.

At this time four A Grammes with four Serrin lamps were used, and, of course, were found to be insufficient for lighting a station 500ft. long by 205ft. wide and about 90ft. high. So it was afterwards arranged to increase the number of lights to six, and instead of using the Serrin lamps I set up six Crompton lamps, and, after running them for one year, they were thrown out, for reasons which I need not here explain.

Brockie lamps were then introduced, with occasionally very marked improved results, but those results have been as variable as the weather, the cause for which I shall have no difficulty in making perfectly plain to any ordinary mind.

During the daytime the engine is used for laundry purposes alone, and is driven to 78 revolutions per minute, the countershaft making 104 revolutions.

At night, when the Grammes (as well as laundry) are in use, the engine speed is raised to 88 revolutions, and, of course, the countershaft speed should increase in proportion, whereas it is a fact that it has been making but 104 to 105 revolutions, the slip of belt giving a decreased speed to the Grammes of about 140 revolutions per minute.

It is also a fact that when the engine has been driven to 95 revolutions the countershaft makes only 105 revolutions, and of this I have from time to time complained to the railway company, but their engineer would never admit it, nor would he tighten his belt until within the last three weeks, since which the lights have been giving the greatest satisfaction; but, whilst this mere temporary arrangement has given the requisite speed for the Grammes, it cannot be relied on.

I need not explain to you what shortness of current means in the working of an electric plant, and as the railway company will not see the necessity of providing proper driving arrangements, after their repeated promises, the British Electric Light Company have detremined to withdraw their plant, and on Tuesday night, the 31st inst., the electric lighting of the station by this system will cease.—Yours, &c.,

JOSHUA HORTON.

134, St. Vincent-street, Glasgow,
October 25, 1882.

A RESISTANCE REGULATOR AND ELECTRIC HEATING APPARATUS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your impression of September 30th you describe "A Resistance Regulator and Electric Heating Apparatus," the joint invention of Messrs. Gustav Pfannkuche and R. E. Dunstan. You state that these inventors "have struck out a new line in the construction of their resistances. They have ascertained that, by embedding coils or frames of resistance in an *incombustible heat-conducting insulating substance*, wires of comparatively minute sectional area can be employed to carry large currents without danger of short circuit between the strands, or of break of circuit through fusion. . . ."

I imagine the fact that *if* a wire be surrounded by an incombustible, heat-conducting, insulating substance it will not be heated to fusion by a considerable current is not of much merit as an original discovery. It would not require a very extensive knowledge of physical laws to arrive at such a conclusion as a deduction from them. But if Messrs. Pfannkuche and Dunstan have discovered a substance, or invented a composition which is incombustible and heat-conducting, and, at the same time, electrically insulating, it is a valuable discovery or invention. And if, as I understand it is, the apparatus is patented, there can be no objection to publishing explicitly the nature of the substance.

As one who is interested just now in constructing a *small* resistance in a limited space, capable of carrying a considerable current, say forty amperes, without dangerously heating or largely varying, I hope fuller information may be forthcoming. If I can obtain the incombustible, heat-conducting, insulating substance, I can make the resistance coil I desire.
—Yours, &c., THOS. F. JEWELL.

Newport, R.I., U.S.A., Oct. 15, 1882.

ELECTRICAL TRICYCLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last number you favoured your readers with the news of an experiment made with Messrs. Ayrton and Perry's tricycle. The subject of road locomotion by electric energy is of immense interest to all classes, I venture, therefore, through your columns, to ask Professor Ayrton to enlighten the public with fuller particulars concerning this "invention."

How many cells do they use to drive their motor, what current and E.M.F., how many hours will the vehicle run on a level road, and what speed, when once charged? What may be the weight and actual power of this motor, what kind of gearing is used to run at any reduced speeds?

A sketch in your valuable paper would prove most instructive. Since the machine has already been exhibited in the streets, there cannot be any further secret about these details.
—Yours, &c.,

A. RECKENZAUN, C.E.

Electrical Power Storage Company, Limited,
Millwall, Poplar, October 30.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: What is the use of an electric tricycle? The Locomotives (Roads) Act, Section 3, enacts that "Every locomotive propelled by steam, *or any other than animal power*, on any turnpike road or public highway, shall be worked according to the following rules and regulations, amongst others, namely:—

"*Firstly*, at least three persons shall be employed to drive or conduct such locomotive.

"*Secondly*, one of such persons, while any locomotive is in motion, shall precede such locomotive on foot by not less than 60 yards, and shall carry a red flag constantly displayed, and shall warn the riders and drivers of horses of the approach of such locomotive, and shall signal the driver thereof when it shall be necessary to stop, and shall assist horses and carriages drawn by horses passing the same." And by Section 4 the speed at which such locomotives shall be driven along a highway is limited to four miles per hour, and through a city, town, or village at two miles per hour.

Is this how electric tricycles are proposed to be driven? That a tricycle *is* a locomotive within the meaning of the Act of Parliament if driven by other than animal power has been recently decided by the Queen's Bench in the case of Parkyns *v.* Priest, 7, 2 B D 313.—Yours, &c.,

31st October, 1882. CHANCERY LANE.

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THE ELECTRICIAN.

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All communications to be addressed to 396, Strand, London, W.C.

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THE CABLE CONFERENCE.

We have so often complained of the backwardness of our own Government in joining international efforts for the furtherance of scientific objects that we are almost compelled to applaud the singular forwardness of our neighbours across the Channel. Paris has always been famed for its political assemblies, and latterly it has aspired to a similar distinction in respect to practical science. This at all events would seem to be true of that particular branch of science which is at present making most stir in the world. Paris is a good place for congresses in general; it is not pre-eminently scientific, but it is undeniably cosmopolitan; everybody speaks French—until he reaches France; and everybody prefers Paris above all places—until he reaches home. There is a general fitness, therefore, about the French capital for gatherings of this sort, and the extreme activity displayed by the Government there in promoting them shows that it has no mind to lose the prestige which the great Electrical Exhibition secured for it.

Compared with the action of the authorities at home the contrast is painfully striking. They did all they could—if doing nothing can be so described—to prevent our taking part in the Exhibition just referred to. The same may be said of the Electrical Congress which followed; more recently they have simply taken no notice of the important Exhibition held at Munich, and the same observation applies we believe to the reassembling of the Congress of Electricians. It is openly alleged that the Foreign Office receives the invitations, but deliberately hides them away for fear anybody should accept them. At all events it is plain that in the main the old established policy of abstention is being pursued in our Government offices, and that they continue to be as slow as ever to interfere with free trade in science; which being interpreted means that they are afraid of being asked for a subsidy.

This being the case their prompt acceptance of an invitation from the French Government to join in a conference relating to submarine cables cannot but strike us as something remarkable and requiring explanation. We have said that Paris is a good place for congresses in general; but neither Paris nor France seems the best place for a congress on submarine telegraphy. The correspondence on this subject, which has been going on for some time past, relating to the security of cable property, and safety in laying it down, has been exclusively, or almost exclusively, between the English Government and English cable proprietors. The English Government, more than any other, is interested in this class of property; and although we should never have expected it to initiate an international conference on the subject, we as little expected it would consent to play second fiddle to any other nation. It is hardly an exaggeration to say that the great bulk of submarine cables all over the world belongs to the English nation. No other nation, nor all other nations put together, have a fraction of the interest we have in bringing about a satisfactory understanding as regards the status of these fragile and costly appliances of civilisation. Yet it is France and not England who is foremost in inviting united action. What is still more strange is that England has shown such unusual complaisance in accepting the invitation. From one point of view this is satisfactory, for we go to Paris with a show of disinterestedness. Possibly if the British Government had issued the invitations they might not have been responded to. Possibly, we say; but, on the other hand, French soil is not exactly neutral ground, and it behoves our representatives to temper their politeness with caution. Britannia, which was once supposed to rule the waves, and still, in fact, does people them, has been asked before now to sacrifice her natural advantages out of good nature towards less-favoured nations. We have a Government in power which, rightly or wrongly, is suspected of being of the yielding sort, though nobody calls it good-natured. We are anxious that our advantages and our rights as the greatest cable-owning nation should be maintained; and on various grounds our anxiety is not lessened by the preliminary steps taken in respect to this Paris Congress.

An inspection of the list of names of the delegates from the various countries represented increases our surprise and uneasiness. They are Government officials every one of them; not a single representative of any cable company is directly or indirectly to be found there. If the questions to be discussed were of a political kind, or were exclusively international, no exception could be taken to this arrangement. But it is obvious that much more than international interests are at stake, and that any decisions arrived at as

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the result of its deliberations will be acceptable to nobody but the Congress itself unless the cable proprietors are consulted. That they must be consulted is, we believe, already apparent; but to hold communication in an extra official way is, at the best, an inconvenient and ineffectual mode of securing the desired end. It is true that a conference of cable companies, English and foreign combined, would be powerless for legislation unless backed by the joint action of their respective Governments. But, on the other hand, a conference of Government officers, although it may result in legislation, can hardly succeed in legislating to the satisfaction of the parties really concerned. If it consults some, it will be said it should have consulted all; if it consults all, it might as well have consulted them at the council table. References by correspondence are necessarily imperfect, inadequate, and liable to misunderstanding. A frank admission to the deliberations of the Congress on equal terms might not end agreeably to the wishes of the companies; but, at any rate, they would depart with a knowledge that their cases had been fairly heard. As it is, very few will be heard, and none, probably, as fully as they desire.

On the whole, the position of the various cable proprietors at this moment is one of uncertainty, and, perhaps, uneasiness. Here is a congress called for purposes not very clearly defined beforehand, and with aims that may be all fair and aboveboard, but which, on the other hand, may be the reverse of these. Few of the Governments own cables to any large extent. France, indeed, has three cables between the mother country and Algiers, while England owns a number of cables connecting various parts of Great Britain and Ireland, &c.; but most of them are parties to concessions or agreements which disentitle them to be trusted as absolutely impartial. If the other unrepresented parties watch the proceedings with vigilance, and a certain degree of mistrust, the Congress has only itself to blame.

THE TRANSMISSION OF ELECTRIC ENERGY.—M. Marcel Deprez has given the following account of his experiments in the transmission of power to a distance by means of electricity:—"The telegraph line placed at my disposal by the German telegraph administration was 57 kilometers long. The conducting wire was of galvanised iron 4·5mm. diameter, and as, for prudence sake, I did not wish to use earth, I asked leave to employ a return wire identical with the above mentioned one. The total length of the line traversed by the current was 114 kilometres, and its resistance 950 ohms. The insulation was good, but differed in no respect from that universally employed on all telegraph lines. The two machines stationed, the one at Miesbach, the other at Munich, were precisely similar, and each offered a resistance of 470 ohms. The total resistance of the circuit was therefore 1,900 ohms. In the first experiment made, we obtained immediately at Munich work (measured in the break) of a value of 38 kilogrammes per second (or $\frac{1}{2}$ horse-power), with a speed of 1,500 revolutions per minute. The generating machine, stationed at Miesbach, ran at a speed of 2,200 revolutions. The two machines being identical, the relation of the work obtained at Munich to the work expended at Miesbach, was, deduction being made for passive resistance of all kinds, equal to $\frac{1500}{2200}$, or more than 60 per cent. The machines used were the Gramme workshop type, modified by me. A heavy rain was falling during nearly the whole period of the experiments. The receiving machine kept up a cascade of water one meter broad and three meters high, by means of a centrifugal pump. The commutators of the two machines showed hardly visible sparks. The heating was scarcely appreciable after two hours' work."

THE LATE JOSEPH CHRISTOPHER LAWS.

We regret to have to announce the death of Mr. Joseph Christopher Laws, which occurred at Brighton on the 26th October, at the comparatively early age of fifty years. Before sketching briefly the career of one whose loss is mourned by a wide circle of friends, it may be well to linger for a moment, thinking of that small band of earnest workers which in the fifties entered into the then new field of submarine telegraphy, and whose energy and perseverance in overcoming difficulties has done so much in the progress of civilisation. It was their farsightedness that led them to make trial after trial, and, undaunted by failure, resumed the arduous labour which ultimately led to such grand success. The late Mr. Laws was one of these early pioneers, and he not only gained the esteem of those with whom business relations brought him into contact, but he gained the love of his fellow workers.

Mr. Laws was born at Brighton on May 31, 1832. He was educated principally at Lancing College. After leaving school he was apprenticed to a watchmaker in his native town, and during his apprenticeship gained the knowledge of practical mechanics which proved so useful in his after career. He came to London when twenty-two years of age, that is, in 1854, as assistant to Mr. Whitehouse, and was engaged in the laying of the first Atlantic cable, in 1858. In 1859 he entered the service of Messrs. Gisborne and Forde, the engineers for the Malta-Alexandria cable. His next engagement was with Messrs. Bright and Clark, assisting in the manufacture and laying of the Persian Gulf cables. After the completion of this work he was engaged with Messrs. Clark and Ford in various cable expeditions, and remained with this firm till 1869, when he was engaged by the Telegraph Construction and Maintainence Company to assist Mr. Willoughby Smith in the electrical department on board the "Great Eastern" during the laying of the French Atlantic cable between Brest and St. Pierre, and remained in their service till the day of his death. During his service with this company he was in charge of the electrical department on board ship during the laying of most of the cables manufactured and laid by the company. During the last two years he held the position of head of the electrical staff at the company's general works. Mr. H. Clifford, the manager of these works, bears testimony as to the esteem in which Mr. Laws was held and the value of his services to the company. He says:—

"It is a melancholy pleasure to me to bear willing and grateful testimony to the most valuable services rendered by Mr. Laws to the Telegraph Construction and Maintenance Company from 1869 to the present time. During this period Mr. Laws had electrical charge of nearly all our important cable laying expeditions. His great abilities and perfect knowledge of his work were keenly appreciated and valued by the engineers in command of these expeditions, and there is no doubt that the uniform success which attended them was not a little to be attributed to the perfect organisation and method of his department.

"His death has caused a gap amongst his colleagues and associates which it will be difficult to fill up. This company has lost in him an invaluable officer, and one who, by his amiability, kindliness, and modesty had endeared himself to all who had the good fortune to be associated with him."

He was interred in Highgate Cemetery on 31st October, and the large number of friends who assembled to pay the last tribute to his memory was evidence of the high place he held in their affections. He won golden opinions during his too brief career, and will long be mourned as a bright example of the highest type of Englishmen—faithful to his friends, modest in his aspirations, true and earnest in all he undertook.

Man with silent admiration,
Sees the glories of creation,
And, in holy contemplation,
Leaves the learned crowd behind.

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ELECTRICAL ACCUMULATORS OR SECONDARY BATTERIES.*

BY PROFESSOR OLIVER LODGE.

No. VIII.

It is now time to consider the action of ordinarily-coated lead plates. Sulphuric acid acts upon most salts and oxides of lead, decomposing them and forming plumbic sulphate. The peroxide escapes this action, but both the protoxide and minium are rapidly acted on when immersed in dilute sulphuric acid, without evolution of gas, but with some generation of heat. The action for litharge is simply,

$$Pb\,O + H_2SO_4 = Pb\,SO_4 + H_2O;$$

but, as litharge has commonly absorbed some carbonic acid from the air, a few bubbles of $C\,O_2$ are commonly evolved at the same time; no other action is perceived, and the colour of the powder hardly changes, though it does become a shade lighter. The reaction for minium is not quite so simple—it is this,

$$Pb_3O_4 + 2\,H_2SO_4 = 2\,Pb\,SO_4 + Pb\,O_2 + 2\,H_2O.$$

No adulteration of carbonate is commonly met with in minium, and accordingly no gas is evolved, but the formation of black peroxide makes itself manifest by a rapid darkening of the immersed powder. In either case, therefore, the quantity of free sulphuric acid present in the liquid is diminished, and if plenty of powder is put into the dilute acid, it will in time get reduced to plain water with no sour taste. A cell containing an excess of oxide of lead, and allowed to stand some time with the acid in before charging, cannot therefore be expected to conduct the charging current properly. When, however, oxide of lead — and especially minium—is packed pretty tightly together, it would be a very long time before its interior parts get acted upon much; for though, no doubt, the acid does soak all through it, yet as it is a very clogging substance, there will be scarcely any circulation or renewal of the acid in its interior. The coatings of an ordinary unformed Faure cell will, therefore, consist of a large amount of unaltered minium, together with a perfectly intimate mixture of peroxide and sulphate, the latter occurring more particularly at the outer face and edges.

To such a cell let a charging current be applied, and consider first what happens at the + plate. If the electromotive force available be not as high as two volts, a clogging crust of hydrated protoxide or of sulphate is formed—see Art. VII.; but if the electromotive force applied is about three volts, the hydrogen of the hydrate is removed, and a brown or puce coloured coat of $Pb\,O_2$ is at once formed, thus:

$$Pb\,H_2O_2 + O = Pb\,O_2 \times H_2O,$$

while some metallic lead is also acted on and apparently peroxidised direct.

As soon as a complete thin coat of conducting peroxide has been formed, the oxygen is liberated at its surface, and is no longer able to reach the lead beneath it, except in small quantities. It, therefore, is ready to oxidise anything it finds to hand, and a good deal of it in all probability oxidises the Pb_3O_4 direct into $3\,PbO_2$; some more acts upon the sulphate of lead present, with the help of a molecule of water, thus:

$$PbSO_4 + H_2O + O = PbO_2 + H_2SO_4,$$

reproducing the sulphuric acid which was absorbed from the solution while the cell was standing idle, while another portion is apt to combine simply with itself and to rise as gas. The quantity of oxygen which escapes under the last head depends very greatly upon the intensity of the current—that is, on the strength of the current divided by the area of the plate—and by keeping the current weak it may be reduced to a minimum. At the same time a slight escape of gas is not usually of very great moment, and it serves a useful purpose in promoting circulation in, and therefore uniformity of, the liquid.

I incline to think it most probable that the direct oxidation of Pb, or PbO, or Pb_3O_4, into PbO_2 is not performed until the oxygen has united with itself into ozone; for I have always found that a visible layer of oxygen bubbles is necessary before any peroxide makes its appearance, and that directly any visible gas appears some peroxide is instantly formed.

I have made special experiments to find out whether peroxide of lead requires for its formation an intensity of current above some particular limit; but I find that an exceedingly weak current is still able to form peroxide, though, of course, with extreme slowness. But its presence is unmistakable, from the violent energy of the return current as long as the peroxide lasts. The strength of current used in charging was about a milliampere; the plates were clean bright lead in dilute sulphuric acid, and each plate exposed an area of about 15 square centimetres. The current was driven by two Groves, and its strength was brought down by adding resistance, not by diminishing the electromotive force. This we know is essential whenever peroxide is to be formed. The coat so formed exhibited colour of thin plates, and in about twenty minutes its colour was a greenish yellow.

Beginning, then, at the surface of the + plate, and spreading out gradually through the mass of stuff with which it is coated, there grows a dense formation of conducting peroxide of lead. It is mainly at the front and advancing surface of this formation that gas is liberated and further peroxide formed. But the peroxide, though conducting, is slightly porous, and a certain amount of oxygen is being liberated pretty well all through it, so that, if a cavity of unaltered minium should happen to be left, it is not altogether, though it is very nearly, protected from peroxidising action. The minium in such a cavity would, probably, however, scarcely be touched until the outer portions had all been acted on; but as soon as this has occurred, and there is nothing more outside to absorb the oxygen, then the opposition electromotive force is so much higher there than it is where there is still an absorbent left, that a good deal of the current may be diverted to the enclosed cavities, in spite of the extra resistance offered by the porous substance in which they are buried.

Now, consider what is happening at the — plate. The nascent hydrogen liberated by the charging current against its surface first reduces the slight coat of rust on it, producing a clear metallic surface alloyed more or less with hydrogen gas. More hydrogen, being liberated against this surface, will either combine with itself and escape as gas, or will act on and reduce whatever oxidised substances are in intimate contact with the lead plate. If the current is too intense, some gas will certainly be evolved, but it takes a much stronger current to liberate free hydrogen from coated plates than it does to liberate free oxygen. There is, in fact, always a slight escape of oxygen, whereas it is easy to absorb every trace of hydrogen. The Pb_3O_4 thus gets reduced, first, no doubt, to Pb O, then, probably, to the sub-oxide Pb_2O, and, finally, to metallic lead. A growth of metallic lead, therefore, begins at the surface of the — plate, and spreads gradually out through the mass of oxide which coats it.

When lead is deposited in this way *from a solution*, as, for instance, from the acetate, it grows in a fantastic crystalline, or "tree," form, but when it is formed, as above, from an insoluble and closely packed powder, it forms a dense, coherent, though certainly porous, cake.

This is not the whole of the matter, however, for the coating consisted of some $Pb\,O_2$ and $Pb\,S\,O_4$, formed while standing in the acid, in addition to unaltered minium. The growth of metallic lead must sooner or later spread into districts occupied almost wholly by these substances, and the hydrogen will be liberated in contact with them. Now the peroxide offers no difficulty, it will naturally be reduced step by step down to metallic lead; but there is some uncertainty with regard to the sulphate. It is certainly *difficult* to reduce sulphate of lead by the action of nascent hydrogen, and if it exists in even small lumps it usually escapes action altogether. When, however, as in the present case, it is so intimately mixed with

* Reprinted from *The Engineer*.

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other substances which have been already reduced, that every atom of it, one may say, is in contact with a hydrogen generating surface, it is pretty certain that it does become reduced, with the re-formation of the free sulphuric acid which had been absorbed.

We observe, therefore, that during the operation of charging the cell, sulphuric acid is being generated at both the plates, so that ultimately the full strength of the solution is exactly restored; in fact it is a trifle stronger than it was, by reason of the absorption and evolution of the elements of water at the two plates. If the plates have been originally coated with a mixture of minium and sulphate of lead, mixed together with the intimacy of firework composition, fresh sulphuric acid is produced inside the coatings at the expense of the sulphate, in addition to that which had been absorbed on standing; the effect of this is usually to whiten, and sometimes to destroy, the cloth in which the composition is wrapped.

The sulphuric acid in any case produced or reproduced during the process of charging is apt to sink towards the bottom of the cell by reason of its weight; and, especially if there has been no evolution of gas or thermal or other convective disturbance, it will be found that the solution near the bottom of a nearly charged cell is distinctly more acid than that near the top. The lower portion of the cell, therefore, conducts the current better than the upper portion, and accordingly it is common to find the bottom of the plates most acted on, and I have seen the composition there fully peroxidised and reduced respectively, while that near the top was as yet barely touched.

In an ideally perfect operation, however, the charging should proceed with absolute uniformity, beginning at the surface of the lead plates and gradually spreading outwards as a steadily advancing plane layer, until the free surface is reached; for in such a process the maximum of gas would be usefully absorbed, and the opposition electromotive force would be kept down as low as possible all the time. But it is next to impossible to secure this steady advance by the layer of operation; for besides the tendency to concentration of acid at the bottom of the cell, which tendency may be counteracted by agitation, the layer is very apt to protrude itself capriciously in one or more places; and wherever such a protuberance occurs it is sure to increase, because of the diminished distance between the conducting surfaces; so that a local growth of metallic lead, or of peroxide, is often found to have penetrated through the composition and to have reached the free surface, where it begins to spread out, screening off a quantity of unaltered substance behind it. The oxide so screened can ultimately be acted upon, because the screen is more or less porous, but it is a slow and wasteful process; it takes a pretty high electromotive force, and a good deal of gas is being uselessly evolved from the already completed portions while it is going on.

In order to diminish the chances of this local inequality of action, the thickness of the composition, and distance between the plates, ought to be very uniform, so that there be no thin places to offer less resistance to the current than others. Again, the edges of the plates ought in some way to be protected; for it is well known in electrolysis that the amount of deposit on the edges of a plate is greater than on the flat portions, and for the same reason the growth of the peroxide and reduced lead is pretty sure to be completed first at the edges and thence to spread over the front face, protecting the middle portions.

Finally, the liquid must not be allowed to become stagnant and of different densities. A fairly powerful charging current, by the heat it generates and the gas it evolves, automatically secures the uniformity of the liquid; though this can hardly be considered an economical mode of stirring. I am by no means sure that the plates would not do better if "formed" in a large electro-plating sort of tank, and afterwards inserted in their separate cells for use. When cells come to be made on a large, stationary, gasometer-like scale, various improvements may be introduced in the directions I am indicating, which in the small portable affairs now constructed are scarcely practicable.

NOTES ON PRACTICAL ELECTRICITY.*

(CONCLUDED FROM PAGE 563.)

On Charging Accumulators.

Suppose that the accumulators are entirely without charge, and the machine polarised rightly, having its residual magnetism such that the + terminal gives a positive current and the — one a negative current. Then in charging we join + (or oxygen) to +, and — (or hydrogen) to —, and all goes rightly. Now suppose that, after the accumulator has acquired a sensible charge, we stop the dynamo machine without breaking the connections. The power of the machine to drive back the battery-current was derived from its velocity, which is gone. Consequently the battery-current discharges itself through the machine in the opposite direction to the proper current of the machine, and reverses the magnetism of the machine. This change is recognised, as I have mentioned, by the effects of the pole-pieces on a pocket compass. When the machine is "straight," the upper pole-piece attracts the unmarked end of the needle. When it is reversed it attracts the marked end.

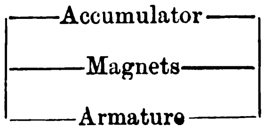
If the machine be then set in motion again, the effect is to strengthen the current in the magnets. But this is now the discharge current of the battery. Consequently the machine proceeds to pump the electricity out of the battery.

This reversal is prevented in ordinary practice in two different ways. In charging the Gramme machines, in general, two machines are employed, of which the one serves only to drive a current through the magnets of the other. This current is wholly independent of the charging current; and the arrangement is consequently not liable to reversal.

The power which is employed in this case to maintain the current in the magnets contributes nothing to the work; consequently this arrangement is not economical. But in a large establishment one small machine may be used to excite several large ones, and the waste is reduced to a minimum.

The best method for charging in general would appear to be the use of machines of the Siemens type, with the field-magnets in a shunt circuit of high resistance; for then the reaction of the battery current seeking to pass backwards into the machine conspires with the forward current from the machine, so far as the supply of the field-magnets is concerned.

Diagram of Circuits in Shunt-Circuit Machine.



But as my machine is not thus arranged, I have had to devise other means of doing the work. I have not seen any account of these processes.

The simplest mode of effecting the charge is to charge in one series, starting by means of a resistance-wire in parallel circuit, thus:—A wire of 5 or 6 ohms resistance, arranged so that it can become red hot without injury, is introduced between the terminals, and the machine driven at full speed. A difference of tension is thus produced between the ends of the wire, which must be greater than that of the accumulators to be charged. This difference amounts with my machine to 70 or 80 volts, or even more. Then, if we have 80 volts and 6 ohms of wire, we get a current of a little over 13 amperes, which is enough to excite the machine well.

The terminals of the battery are now joined up to the terminals between which the difference of tension is established, + to + if the machine is straight, + to — if reversed. The existing difference of tension drives back the battery-current, and a charging current is set up. With the 30 cells

* By R. H. M. Bosanquet, Fellow of St. John's College, Oxford, in October number of *Phil. Mag.*

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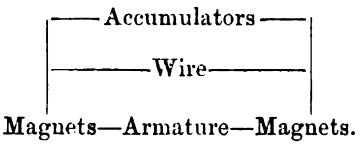
in series I find that the current traversing the accumulators is about 10 amperes under these circumstances.



The machine is then traversed by the double current of more than 20 amperes from both battery and resistance-wire. Great statical resistance to the engine is consequently developed, and the magnets are well excited; but the current through the 6-ohms wire goes to waste, and, in fact, the wire is kept nearly red hot. A large power is required to maintain this state of things. The last step is to remove the wire, leaving the battery with the current of about 10 amperes passing through it. The resistance at the machine is reduced to about one fourth by the halving of the current, and the engine quickens its speed; but, on the other hand, in order to maintain the difference of over 70 volts when excited only by 10 amperes, the machine requires a high speed.

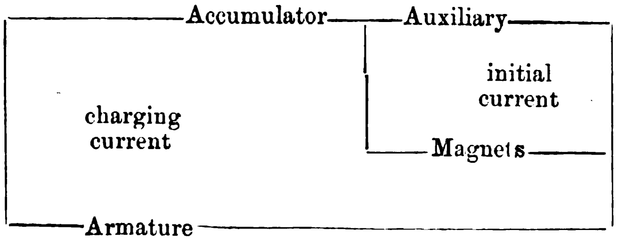
Consequently there is a period of instability at the moment of removing the resistance, and the machine is often reversed before the high speed is established. The only means of obviating this are (1) to cram on every available pound of steam at the moment, (2) to execute the two operations of joining up the battery and removing the resistance in such quick succession that the speed has not time to fall. By the use of both these precautions I have generally succeeded in starting the charging in this form; but until I had acquired considerable experience and a thorough understanding of the conditions I frequently failed.

When this arrangement is once started, and if sufficient power is available to keep it going, it is not only the most economical method of charging with this machine, but it is more economical than any other method, excepting the case where the magnets form a shunt circuit of very high resistance indeed.

The objection to the arrangement in question is that there is a very small margin between the tension of the battery and that of the machine which has to overcome it; consequently, at the slightest check to the steam, and frequently without any apparent cause, the battery-current will overpower the tension of the machine and reverse it. The motion of the machine tends to reinforce the current of the battery in the new condition, and the resistance of the machine is small, so that a tremendous current, probably more than 50 amperes, is poured through the machine, and the electro-magnetic attraction resulting is powerful enough to stop the engine. This reversing is indicated by a hiss of the belt on the pulley, followed by the stoppage of the engine. The person in attendance has immediately to break the circuit, or the whole store of electricity would soon be poured uselessly away.

With the limited power at my disposal I have never been safe from reversals in charging in series in this manner when the number of cells to be charged amounted to 20 or more.

Another method of starting the charging in series is to throw a current through the magnets from an auxiliary battery or from a series of accumulators already charged, and then introduce those to be charged. The connections are as follow:—



In this arrangement one terminal of the magnets must be disconnected from the armature, and the magnets made up into one circuit.

When the charging is started, the auxiliary battery is removed. An instability of the same sort as that above described takes place.

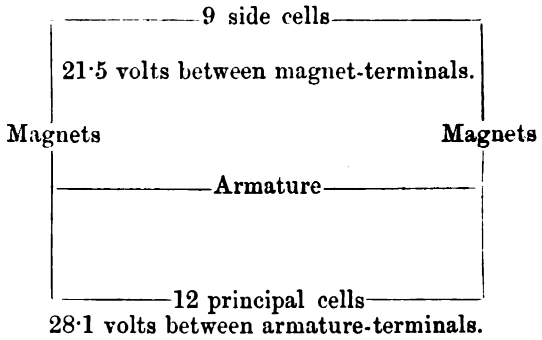
This method is not superior to the last, and is troublesome from requiring the auxiliary battery.

A very simple mode of charging, where the cells are all similar, is to make them up into two or more parallel circuits, according to the electromotive force available. When there are different kinds of cells this method is troublesome, as the two circuits have to be exactly balanced, and this must be done by trial. Further, the red-lead cells alter during charging as if their resistance diminished, which I take to be caused by the decomposition of the sulphate of lead with evolution of sulphuric acid. It is then necessary to keep watch at the galvanometers in the two parallel circuits and rearrange the circuits when necessary, which is very troublesome. Latterly, however, I have used this method more. With my machine it would be more suitable for charging about 40 cells. The charging is started with a resistance in the same way as in the first case.

The next method is an interesting one; I found it useful when the cells were in good condition, with low resistance and with about 20 cells; but I have used it also with 30 cells. When the resistance of the cells is high, it is better to use the last method with 30 cells.

I call the present method the method of balanced charging. It arose in this way:—I began by putting the magnets in a shunt circuit, with a resistance in the magnet circuit; then accumulators could be charged in the main circuit (armature-terminals), and the current spent in heating the resistance in the magnet circuit went to waste. I therefore tried substituting cells for the resistance in the magnet circuit. I put the two similar quantity galvanometers in the two circuits, and varied the distribution of the cells until the deflections were equal; so that all the cells were getting uniformly charged. I found at once that under certain conditions a balance was established, so that the tension-difference on the two sides of the magnet circuits was small, and that, so long as the balance was maintained, there was no tendency to reversal.

The following scheme will explain one of these arrangements:—



In this case I had a balance when 9 amperes of current were passing in each circuit.

It is clear that the current through the magnets is due to the difference of tensions between the two sets of cells; consequently,

	volts.	
Tension of 12 cells =	28·1	(measured)
„ 9 „ =	21·5	„
	6·6	

and, dividing by the measured current of 9 amperes, we find ·73 ohm for the resistance of the magnets. This corresponds well with my direct measure of ·74, and less well with the resistance given by the makers, ·77.

The balance is a function of the current; and if the power in action be varied, the current in the principal cells changes faster than that in the magnet circuit (or side cells). It is to this circumstance that the stability of the arrangement is due.

In order to give foundation for the theory of this arrangement we have to represent the variation of the tension of the cells with varying current. We may represent the course of the changes sufficiently for this purpose, according to my measures, by assuming that the tension varies with the

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charging current, so that it is 1·9 volt per cell when at rest, and 2·4 per cell when the current is 10 amperes, *i.e.*, it varies $\frac{1}{20}$ volt per cell per ampere. The same rule expresses fairly well the diminution of tension when the freshly charged battery gives out a current. I shall return to the question of the rationale of this, and for the present assume general values, and that the change of tension is proportional to the current.

Let E be the tension of one cell at rest,
x the current in the principal cells,
y the current in the side cells,
ϵ the change of tension per cell per ampere.
m the number of the principal cells,
n the number of the side cells.

Then,
Tension of armature terminals, or of principal cells
$$= m(E + \epsilon x);$$
Tension of magnet terminals, or of side cells
$$= n(E + \epsilon y).$$

Then, if R be the resistance of the magnets, since the difference of these tensions drives current y through R,
$$m(E + \epsilon x) - n(E + \epsilon y) = R y;$$
or,
$$(m - n) E + m \epsilon x = (n \epsilon + R) y;$$
$$\frac{dx}{dy} = \frac{n\epsilon + R}{m\epsilon}.$$
Put $n = m - d$, where d is the difference between the principal cells and side cells; then
$$\frac{dx}{dy} = 1 + \frac{R - \epsilon d}{m\epsilon};$$
which is > 1 if $R > \epsilon d$.

In the case above given,
$$\epsilon = \cdot 05, \quad R = \cdot 74, \quad d = 3;$$
whence $\frac{dx}{dy} = 2$ nearly, and the change of the current through the principal cells is twice that in the magnet circuit.

Of course it is the change in the magnet current that alters the excitation, and gives rise to instability; so the more we throw the change off the magnet current the more stable the arrangement will be.

The behaviour of the balance as ascertained by experiment corresponds with this theory. The magnet current alters more slowly than the other.

To deduce the magnitude of the balancing current in any particular case, put $y = x$ in the equation
$$m(E + \epsilon x) - n(E + \epsilon y) = R y;$$
$$(m - n) E + \{(m - n)\epsilon - R\} x = 0.$$
Let $m - n = d$ as before,
$$x = \frac{E}{\frac{R}{d} - \epsilon}.$$
If $R = \cdot 74$, $d = 3$, $\epsilon = \cdot 05$,
$$x = 5E.$$

If we assume $E = 1 \cdot 9$, $x = 9 \cdot 5$, which is near enough to 9, the observed value, to show that we have a general representation of the facts. The constants are not determined with sufficient closeness for accuracy.

Again, suppose we wish to charge with a larger current. Put $d = 4$ in the above; then we find for x the balancing current 14·6. So that we have only to increase the difference between the two sets of cells.

Again, supposing we wish to use a smaller current, put $d = 2$. Then $x = 6$, nearly; or the balancing current is about 6 amperes. Both of these conclusions have been verified experimentally.

With reference to the assumption just made as to the dependence of the potential on the current, and generally as to the constants of the accumulator, if we calculate the resistance of a cell of the accumulator from the data available, assuming that the plates are 1 centim. apart, and that the sulphuric acid has a strength even considerably less than 10 per cent., which is its original value, we find a result which is extremely small. In fact, specific resistance*
$$\cdot 2 \text{ per cent.} = 4 \cdot 47 \times 10^{10},$$
$$8 \cdot 3 \text{ per cent.} = 3 \cdot 32 \times 10^{9}.$$
The intermediate value 10^{10} represents our case with sufficient approximation.

The edge of each plate is about 30 centim., and its surface not far from 1,000 square centim.; so we may consider the conducting solid as consisting of one plate of unit thickness, and surface somewhat exceeding 10,000.

The resistance, therefore, would be $\frac{10^{10}}{10^4} = 10^6$, or the thousandth of an ohm roughly. This prevents us from assuming that the change of potential caused by current is due to the spread of the tensions along a resistance according to Ohm's law. And it appears probable that any change of tension due to such a source is negligible so long as there is acid in the solution.

A key to the nature of the phenomenon may be found by considering what happens when the cells are being exhausted. If a current of 10 amperes such as I have used for charging be demanded from the accumulators the tension falls off. If the demand continues the cell becomes exhausted. If we let it stand it will recover itself—just as is the case with a Leclanché cell, for instance †

Now the simplest way of accounting for this, as well as for the rise of tension in charging, is to suppose that the chemical action, in which the storage consists, does not actually reside on the surface, but penetrates to a certain extent into the subjacent layers of the mass. It is easily conceivable that such an action should be only capable of transference through the mass at a certain rate; that when too large a current is demanded from the cell the chemical change does not return from the interior layers to the surface with sufficient rapidity to maintain the current; and that when, on the other hand, a high-charging current is employed, it cannot get away fast enough into the substance from the surface, and is accumulated there and forced to a higher intensity. It is simplest to assume that this heaping-up is directly proportional to the current which causes it.

So far as the excitation of the magnets goes, the method of balanced charging is more economical than charging in series; but, as a double current passes through the armature, there is some considerable waste in heating it.

The electro-magnetic attraction of the machine is in this case, roughly, double that of charging in series (assuming for the moment that the magnetisation is proportional to the current). This gives the engine a better hold of its work in the case considered without making the load so very heavy as when the double current passes through both magnets and armature.

The lead of the dynamo machine, or the angle at which the brushes have to be set forward on the commutator, is about double what it is under other circumstances. This is no doubt due to the exalted magnetism of the armature due to the double current taking longer than usual to be affected by the comparatively weak field-magnets through which only a single current is passing. This appears to point to the reduction of the lead by the employment of more powerful field-magnets. In all cases the lead must be ascertained by its being the position of least sparking, and the brushes set pretty closely to it, otherwise the brushes are burned away and the sparking is unpleasant.

Having charged the accumulators, I divided them up into circuits as required, and employ them to work my electro-pneumatic and other appliances. I have driven everything for a week after a charge of a couple of hours, but on account of the local action in the red-lead cells this is not a very advantageous course; and latterly I have preferred to charge for

* These numbers are taken from Professor Everett's "Illustrations of the C.-G.-S. System."

† So, if we try to drive an arc light, we can get for a short time a current of more than 20 amperes and a good light; but the battery soon begins to be exhausted, and a most curious effect sets in: the alternations of exhaustion and recovery succeed each other with great rapidity, and the carbons begin to chatter in a most extraordinary way.

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half an hour in the morning of each day. If the charge is meant to last, of course the currents must be used economically.

There are considerations, however, connected with the inevitable variation in the power of the current when any description of cells is used as a source of electricity which make me already doubtful whether this alternate procedure will answer, and whether it may not be necessary to use the cells with the machine running simply for the purpose of sluicing off small currents with fairly constant differences of tension at their sources from the main current of the machine. It is even possible that simple pairs of lead plates in acid without preparation may be sufficient for this purpose. But the discussion of this matter must wait until my uniform rotation-machines are in a more complete state.

I will close with an experiment showing, in a manner suitable for the lecture-table, the development of a counter electromotive force in the dynamo when driven by a current from the accumulators.

I place a Swan lamp in parallel circuit with the machine. Then, so long as the machine is at rest, the lamp does not burn. But when the machine is in motion, as the velocity increases the counter electromotive force is set up, and the passage of the current through the machine more or less completely barred. The lamp in the parallel circuit then burns up. If the machine is stopped by a brake or overloading, the lamp is extinguished again.

LITERATURE.

Electro-Métallurgie: Ses Diverses Applications dans les Arts et dans l'Industrie. Par C. Alker, Fondateur de l'Industrie Galvanoplastique en Belgique, &c. [Bruxelles, Librairie C. Muquardt, Rue de la Regence, 45.]

This little work is divided into two parts—electro-plating and electro-chemistry. It is intended more as an extended essay to indicate to sculptors, engravers, architects, decorators, &c., the numerons applications to which electro-metallurgical operations may advantageously be applied. According to the preface, the author has the intention of writing at some future time a practical treatise on the subject. The various applications of electro-deposition are described in a clear and simple manner, and the superiority of electro-deposition insisted upon. The second part, treating of electro-chemistry, hardly treats the subject in the manner suggested by the title. It merely refers to the electro-deposition of various metals, and defines electro-chemistry as the art of covering a common with a more valuable metal. The author thus defines this part of the work:—"Comme nous l'avons dit au commencement de cet écrit, l'*electro-chimie* est l'art de recouvrir les métaux, ordinairement les métaux communs ou autrement dit les métaux pauvres, d'une couche protrectrice continue et adhérente d'un métal plus riche, plus solide, moins oxydable et par conséquent moins altérable que le métal recouvert."

The information given about gilding, silvering, &c., is but general, and intended more to induce a greater interest in the work than to give details of the various operations.

Die Magnet-Elektrischen und Dynamo-Elektrischen Maschinen und die Secundar-Batterien. By Gustav Glaser-De Cew. [A. Hartleben, Vienna.]

This book forms the first of a series of ten volumes on electrical subjects, or, to speak more correctly, eight volumes and two supplements. The second supplement, forming Vol. X. of the series, will be very interesting, being devoted to electrical formulæ, with terminology in German, French, and English. The volume before us extends to some two hundred and sixty pages, and is devoted principally to the discussion of magneto and dynamo-electric machines. It commences with a short history of such machines, taking as the starting point Faraday's discovery. Then comes Pixii, and so onward to the better known machines of the present day. The machines selected for description are illustrated, and in some cases the description is supplemented by a brief discussion of the theory and action of such machine, such discussions being also illustrated to make the reasoning quite clear. Ampère's theory as to the motion of currents is used to explain the action in the Pacinotti and Gramme rings. Due credit is given to Siemens for his armature, as well as to the inventors above named. The Alliance machine of long ago, and the De Meritens machine of later days, with others, are described to exemplify the type magneto machines. From the time of Gauthenot, in 1802, onwards the investigations upon "polarisation" are noted, ultimately developing the Planté battery in 1859. The data relating to the Planté and Faure batteries are those which gave such an impetus to experimental work in the direction of storage. The mathematical results of Sir W. Thomson's investigations relating to machines, as given at the York meeting of the British Association, the formulæ of Th. Du Moncel relating to electro-magnets, &c., are incorporated in the work, as is a description of the measuring instruments of Ayrton and Perry, showing that the author has made himself thoroughly acquainted with the foreign as well as the German literature on the subjects he treats in this volume.

The Action of Lightning, and the Means of Defending Life and Property from its Effects. By A. Parnell. [Crosby Lockwood, and Co., 1882.]

The book is divided into three parts, the last of which is, perhaps, the more interesting, as it treats of the practical measures advocated by the author. The first part consists mostly of quotations obtained by very extensive research on various topics connected with the subject of the work, such as "The Application of Rods," "The Inspection of Rods," &c. The second part deals with the theory of the action of lightning, and is, again, a *resumé* of what has been written on the subject by others. It is, as we have said, in the third part, that Mr. Parnell makes suggestions. Many of these suggestions are good, some are, under present conditions, impracticable. He divides the discussion under the following heads:—(*a*) The defence of larger areas, counties, countries, districts, towns; (*b*) the defence of constructions, buildings, mines, ships; (*c*) the defence of individuals. He points out that no statistics are regularly compiled by the authorities, and suggests that if this were done we should gain a vast amount of information from the careful consideration of the recorded fact. We do not discuss the questions, but merely call attention to the work, which contains a vast amount of information given in a compendious form, which, so far as we know, is to be found in no other work. This information is very interesting; it will bear reading, and, what is more, provokes a desire to know more of the subject.

Useful Information on Electric Lighting. By Killingworth Hedges. Third Edition, 1882. [E. and F. N. Spon, London and New York.]

This little book, which has, however, grown considerably in passing through several editions, has been written with an object, viz., "To give general information as to the practicability of introducing the electric light in preference to the system of lighting at present adopted." Like all books written from such a point of view it affords a good field for hypercriticism. Those who are not content and give no credit unless a schoolboy writes down four roots as the result of his attempt to solve $x^4 = y$ will be apt to look at everything that is not rigidly exact with clouded brow. Our opinion is that Mr. Hedges's work, while not bearing close criticism, contains a good deal of the "general information" it is intended to give. The unscientific may read the work and obtain a general idea of the apparatus used in electric lighting, also make an acquaintance with some of the problems that are before the world as to future applications of electricity. They will find the cost of working the electric light discussed, and the workman will find here and there hints and directions to guide him in his work.

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EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.

The eighteenth ordinary general meeting of this Company was held on the 1st inst., at the City Terminus Hotel, Cannon-street, under the presidency of John Pender, Esq., M.P.

The SECRETARY read the notice convening the meeting and the minutes of the seventeenth ordinary general meeting of the Company, held on the 19th April last, which were confirmed by the present meeting and signed by the chairman as correct. The report, of which an abstract has appeared in *The Electrician*, was taken as read.

The CHAIRMAN then said: With regard to the revenue the gross receipts for the half year ended June 30 last amounted to £207,119 against £191,580 in the corresponding period of 1881, showing an increase of £15,539. Of this, £3,728 is due to profit on exchange and additional interest on loans during the half year, and the balance, £11,811, represents the growth of traffic. The expenses for the half year were £50,355, against £54,098 in the corresponding period of 1881—a decrease of £3,743. This is caused by the expenses of the repairing ships being reduced in consequence of the charter of the screw steamer "Agnes" to the New Zealand Government for the repair of their Cook's Straits cable. The net revenue for the half year was £113,393, against £94,755 for the corresponding period of 1881, showing an increase of £18,638. During the half year two quarterly interim dividends, together with a bonus of 1s. per share, making a total of 3 per cent. for the period, have been distributed. As regards the new Batavian cable, the Board have charged £30,000 against the half year's revenue in payment of the balance of its cost, leaving £23,468 to be carried forward. This cable, with one exception, when it was broken by a ship's anchor, causing an interruption of twelve days, has worked well since it was put down in November, 1881. It may likewise be interesting to mention that the brass-ribboned cable laid some four years ago in the original Java-Darwin cable has so far successfully resisted the action of the troublesome little insect, the teredo, which was found to be so destructive on the old Batavian section. The remaining sections have not been interrupted during the half year beyond a few hours whilst repairing the numerous small faults which have developed from time to time. These are some of the facts connected with the working of the system during the last half year, and before asking you to approve of the report and accounts I am, as usual, desirous of making a few remarks. Generally speaking, our system has been working well during the last six months. You are all aware that an interruption, extending over a considerable period, occurred from the state of affairs in Egypt on the Eastern Company's service across the Isthmus of Suez. That, I am glad to say, is now restored, and in such a way as I hope will prevent, probably, in the future, any recurrence of similar interruptions. But, fortunately for this Company, as well as for the Eastern Company, the arrangements we had made with the Indo-European Company enabled us to carry on our traffic, if not as efficiently, at all events without any loss to the Eastern Company, and, consequently, without any loss, as you may have seen from the accounts I have just read, to the Eastern Extension Company. We have in our system given very special attention to making our system as efficient as it is possible to make telegraphic communication. We have told you how we have been troubled with the teredo. We have done everything we possibly could, as far as science directed us, to become the masters of that little insect, and we have succeeded in resisting it. I am glad to say that we have positive evidence that we have been able to make such a cable as protects us against the ravages of that insect. We have still in our system some 230 or 240 miles of cable which is not what I may call "armour-plated" against that insect. It is our intention to replace this by a cable which will be perfectly secure—taking up the old one, which we shall utilise to considerable advantage I hope, and, at the same time, putting our system in a thoroughly efficient condition. You will observe from the accounts that we have made a very important addition to our system which we have charged to our revenue. When that was first indicated I stated that about £95,000 would be required to make this Batavian system. We have now, I am happy to say at this time, wiped it out. Our capital, therefore, has not been increased, but our system has been most materially strengthened for dividend paying [applause]. That is pretty much the policy that we still continue to pursue. We wish to be in possession of such a system of telegraphy that its efficiency will not only be appreciated by those who use it, but that its security will be so much greater in the future than in the past that it will enable us to have more confidence in our dividends than we have had hitherto. We have also in view some additions to our system. I do not desire that they should add to our capital, but additions that will enable us to utilise our cable as I have indicated—when taking it up in one place, putting it down in another, so as to secure an alternative line—and at the same time embrace parts of the world we have not had within our scope. All that we have in view, and looking at the satisfactory accounts which we put before you to-day, and at what we intend to do in the future—I hope you will consider our position very satisfactory. With these remarks I beg to move the following resolution:—"That the report and accounts of the directors now submitted be received and adopted."

The Right Hon. VISCOUNT MONCK: I beg leave to second that.

The CHAIRMAN: Now, gentlemen, before I put the resolution I shall be glad, if any gentleman has any remark to make, to listen to him, and give any explanation that may be required.

Mr. JOHN NEWTON: Mr. Chairman, it is not possible for any one to make any adverse criticism on the position of the Company. I think this Company holds one of the strongest positions of any of the telegraph companies in existence, but I am rather sorry to say that we are not paying an equal dividend with the best of the recent cables. I see no reason why 7 per cent. should not be paid by this Company. I quite endorse the policy of a reserve fund, but I do not understand the policy of reserving in this Company as you have. For example, you are adding at the rate of £85,000 or £90,000 a year to the reserve, and the world at large does not know that. They simply have it in your accounts that you are reserving £55,000. Now, the present generation of shareholders are entitled to have it known among the public that the Company is increasing its reserve in such magnitude. The form in which you put the accounts of the reserve fund does show the amount of money reserved, and I take some credit to myself in getting that form adopted, showing the amount of the reserve fund which is used for capital purposes. We can there see that it has been increased by £236,000, which does not appear in the total figures, and I think the present generation of shareholders should have the full measure of benefit that they can from that. As it requires under £20,000 to pay an extra 1 per cent. dividend, I think the shareholders of this Company ought to have that amount of dividend in a company so prosperous as this is. The revenue of the Company which is used for capital purposes goes to benefit our descendants instead of ourselves. No other company in existence, I think, carries so large a sum to reserve as you are doing—at least, no company with a system of duplicated cables. I think we should also have it very clearly shown in the accounts that the £30,000 you are transferring from revenue has been first transferred to the reserve fund, but I think that the amount you require to renew cables should be taken bodily in one sum, without splitting it over half-years. It is only a question of figures after all. You might as well have taken the £30,000 twelve months since as put it in the reserve fund, and £60,000 now. The shareholders would then have seen clearly and unmistakably that the property had been increased by that amount of money out of revenue. We should have had the full benefit you spoke of, of not increasing our capital, and I think your first security holders, the debenture holders, would have had the satisfaction of seeing what a valuable property you possess. I think you would be prepared for that measure of advantage to telegraph companies of issuing debentures at 4½ or 4 per cent., and that that would be considered satisfactory with the class of telegraphs with which you are associated—those laid by the Telegraph Construction Company. I do not know whether it is that you do not wish to appear too far ahead of the Eastern Company, but we ought to go on to 7 or 8 per cent., and I think the time is not far distant when we shall pay far more than the Eastern Company. This Company occupies a position not held by any other company that is not protected by subsidy or special concession. It is not possible for a cable to be laid in competition with our system. The Americans certainly do try to trench on the field of telegraphic enterprise, but they will hesitate before they make a cable to China across the Pacific Ocean. There is not a possibility of trade or enterprise of any kind coming forward and laying a cable to islands where the traffic would not be sufficient to give a return upon the capital. We have no prospect of competition, and, therefore, I think that we, the present generation of shareholders, should have something more than 6 per cent., and that we should go on to 7 or 8 per cent.

Mr. WILLIAM ABBOTT: Before you answer the last speaker, I think I express the views of all shareholders in submarine telegraphy that it would be an unfortunate circumstance if we ever entered into the spirit of emulation in desiring to make one telegraph company pay a larger share of dividend than another, apart from the prudent course you have seen fit to adopt in strengthening your reserve fund. I think the fact that your stock stands so well in the market demonstrates sufficiently the prudence of your management, which the shareholders are quite ready to endorse. There is one point in this report that you have not touched on—that is the reserve fund. I see on looking down the list of the securities they cost about £300,000, but I think I am right in saying that if the stock were taken to-day its value would be considerably more. Do not imagine that I wish you would increase the dividend out of that, but I think it is a fact you should let your shareholders thoroughly understand—that, so far from desiring to make the best of everything, you are placing everything connected with the Company on a thoroughly sound basis. There is one other remark I wish to make, and I hope the shareholders will not think it is irrelevant to the present meeting. I consider it very much to the purpose. When I had the pleasure of meeting you in New York you were then, as is only proper, regarded as a bright and shining light in the telegraph world. Those intelligent Yankees got hold of you, or, to use a sporting phrase, you were "got at." A great deal has been made over here of the desire of the Americans to identify you personally and those with whom you are associated in various telegraphic enterprises with which they are connected. Now, sir, I should be very sorry indeed if you were to lend the benefit of the power of your name to any such combination as the Western Association of Telegraphy. I have no doubt that you have taken a wise course. In fact, I heard before I left America that you had taken what I consider a very wise course, but the shareholders and the public here do not know what was the wise course you took, and therefore I think it is particularly opportune on the first occasion of your meeting your own shareholders, and those of the Globe, with which you are connected (the Globe company being very largely interested in this Company, I think holding the voting power of the Company), that you should state to them that it was not your intention, and why it was not your intention, to identify yourself with the Western Union Company by joining the Board. If I am right in my surmise it was highly creditable to you. When men in your position are so freely attacked when they do anything wrong, it is right that it should be known when they do what is right. I wish you also to inform the shareholders present, and the public in general, that it is not your intention to "father" the Western Union Company with the view of getting a quotation on this market.

The CHAIRMAN: I will reply first to Mr. Newton. I am not at all astonished at Mr. Newton's criticisms. Probably were I in Mr. Newton's place I should express pretty much the views he has expressed on behalf of the shareholders; but I am quite sure that Mr. Newton will agree with me in this, because he touched a very important point in our policy, and that point is the getting of our debentures out at 4 per cent., if we possibly can. I am sure Mr. Newton will agree with me that we can only do that when we have such a reserve as will enable us to make those bonds beyond all question secure. I am pretty sure that we understand one another on that point, and while I should always be glad to hear from Mr. Newton, or any other gentleman, similar criticisms, I shall always be prepared to state my reasons when I think it is not yet time to increase our dividend. We are increasing the value of our property very materially, and I just ask you, do not expect to have your cake and eat it too. Be satisfied with the steady dividend you are getting, and the increase in the value of your property. That increase tends to enable us to carry out a policy which we think will establish the bonds of this Company in a secure and permanent position as an investment. As to putting sums first to reserve fund and then

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to capital, Mr. Newton knows that that is pretty much a matter of account.

Mr. Newton: Exactly.

The Chairman: But do you not think when people look at the reserve fund and see it decreased they misunderstand it? Is it not better to keep things pleasant? The course we have taken keeps the reserve going up instead of going down. Mr. Abbott has spoken very strongly, but let me assure Mr. Abbott of one thing, that the interests and the honour of the gentlemen associated with me in submarine telegraphy are as dear to me as my own, and any course I pursue you may depend will be for the benefit of the cables and those interested in them. I cannot say anything more at present further than that I was not caught by Mr. Field or any other gentleman. I received generous, liberal—I might almost say munificent—treatment in that country. I shall always speak well of it on that account, but as to the remarks Mr. Abbott has made, probably by and by we shall be able to discuss those questions in another place, but not at this meeting. Meantime, I assure you that the honour of the submarine system is safe, I believe, in my hands. He then put the motion and declared it carried unanimously, and added that that closed the business.

Mr. Abbott: I wish to propose a vote of thanks to the chairman and directors for the very able report they present. I have not the slightest doubt that Mr. Pender will take care of the interests confided to his keeping, and will take care of himself, notwithstanding the questionable company he has lately been in [laughter].

Mr. Newton: I will second that resolution. I should like to say one or two words on the point I raised. I do wish to see our reserve fund as a fund for replacing the cable. I do not like to see it standing as a fund for the payment of repairs to cables. It is not understood by those who do not come here, and hear your speech, or read it afterwards, and it would be more advantageous to the whole of the shareholders if the reserve fund were shown to be what it is—really available for the replacing of your cable.

Mr. Abbott put the motion, which was carried unanimously.

The Chairman: I am very much obliged to you for the honour you have done us. We feel that our concern is prosperous, and at the same time, that we are pursuing a policy which has commended itself to the body of our shareholders, and we thank you for the continued confidence you show in us.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).

The eighteenth ordinary general meeting of this Company was held at the Cannon-street Hotel, E.C., on Oct. 27, 1882, under the presidencyof the Right Hon. Viscount Monck.

The Secretary (Mr. Richard Collett) having read the notice convening the meeting and the minutes of the last general meeting, which were confirmed by the present meeting, the report of the directors was taken as read.

The Chairman stated that the first matter of consideration was the condition of the working plant, which, he was happy to be able to tell them was perfectly sound, and within the last few hours they had received the information that the fault (referred to in the report) in the old Lisbon-Madeira section had been removed. The second subject to which he desired to draw their attention was the receipts, and a reference to the table appended to the report would show that from the opening of the cable they had gradually but steadily and progressively increased. He was happy to tell them, too, that since the date to which the accounts were given—June 30 last—the increase in the receipts had been going on at an accelerated rate. With regard to their expenses for the past half year they had been £23,155, or £10,688 more than in the previous half year. That increase seemed very large, but £10,406 was due to the repair and renewal of the Pernambuco shore end, which gave out last year. The real increase in the expenses had been only £282, which was principally owing to their increased traffic. This year the shareholders would be receiving a dividend of 7 per cent., which would be the second year in which they had made such a division, and in the previous year the dividend was 6 per cent. If the present were an ordinary occasion he should now sit down, having stated what he believed to be a very flourishing condition of affairs, and move the resolution; but he thought that the fact that they had commenced duplicating the cable, marked an epoch in the history of their enterprise, and justified him in giving a brief review of what they had done from the beginning, and of calling their attention to their prospects for the future. The Company was originally started in 1873, but the delay in the completion of the Lisbon-Madeira section of the cable prevented them from commencing work before July, 1874. Since the establishment of the Company the shareholders had received on the average 5 per cent. on their capital—a little more, in fact. It had often been said at their meetings, and meetings of a similar character, that 5 per cent. was not too large a dividend on money sunk in the sea. Well, he had never disputed the fact, but the policy of the directors had always been so to manage the affairs of the shareholders as to get rid of the element of uncertainty, which was the element that made 5 per cent. a bad return for money invested in such an enterprise. It had also been stated that they paid a very bad dividend, but put very large sums to the renewal fund. The policy, however, of the directors had been, by rendering the investment of the shareholders secure, to make it apparent that 5 per cent. was not a bad dividend for money invested in a submarine cable. They were now reaping the benefit of that policy, for the duplication of the cable between Lisbon and Madeira had been effected without calling on the shareholders or the public for a shilling of capital. Some explanation was due to them as to the action taken in this matter by the directors. He had often stated that, as they had power enough in their single cable for transacting all the business entrusted to them, they should endeavour to postpone as long as they possibly could the duplication of the cable, because the moment a cable was put in the sea it began to deteriorate. With the improvements, however, which had been made in the past eight or ten years, the deterioration was not at all of the same character as originally. In the case of the Anglo-American Company, of which he was chairman, they had this year picked up a cable that had been thirteen years in the water, in, he believed, over 2,000 fathoms, and repaired it; and it was now practically doing better work than when it was laid down. That he thought was a consolatory piece of intelligence for those who had invested their money in sea cables. About May last their electricians reported that a serious fault had developed itself in the Lisbon-Madeira section of their cable. Having only one cable, if they had attempted to repair the fault they must, under the most favourable circumstances, have suspended traffic between Lisbon and and Brazil. To ascertain where a fault existed in it, an amount of electrical force must be applied which caused a risk to be run of breaking down the cable altogether. The Board, therefore, came to the conclusion that, under all the circumstances, the best course to take was to lay down first a new cable between Lisbon and Madeira, and then proceed to repair the old one. They reluctantly came to that conclusion, as they had been anxious not to commence duplicating as long as they could put it off, but they had thought it wise, under all the circumstances, to take a course which had enabled them to avoid suspending their communications, and to continue taking their income without any break whatever. At the same time, they still adhered to the policy of postponing as long as they could the duplication of any further portion of the line, and though they had money in hand to do either section, they would not do so till the necessity obviously arose. As he had told them, they had received an average dividend of more than 5 per cent. The reserve fund, after paying for the new Lisbon-Madeira cable, amounted at this date to about £328,000, and the effect of that upon the value of their property was apparent. For a long time their £10 shares hung at between £7 and £8, and they were now between 12 and 13. He saw them quoted the other day at 12½. That meant that their capital, having received 5 per cent. for eight years, was 25 per cent. more valuable than when the Company began. He thought that without egotism the Board might congratulate themselves on the management of a concern exhibiting such a result. They would pursue the same policy as hitherto, laying by a sufficient sum to meet any demand for the purpose of renewal, and give every shilling beyond that to the shareholders in dividend. He had frequently been asked when he thought the time would arrive when there would be no necessity to make further additions to the renewal fund. That was something like asking the Chancellor of the Exchequer when he would have no occasion for taxation. He was afraid that the Chancellor of the Exchequer was not likely to see that time arrive, but he (the chairman) thought he could, at some little distance off, if they were blessed in future with the same immunity from accidents which they had enjoyed in the past, see the time when they might suspend any further additions to the renewal fund, and divide the whole receipts among the shareholders. No one would rejoice more than he when that course could be taken consistently with regard to the interests of the shareholders and due regard for the permanence and well-being of the Company. He then moved the adoption of the report and accounts, and the payment of the dividend and bonus recommended—both free of income-tax.

Sir J. Anderson having seconded the motion,

Mr. John Newton made an inquiry respecting the appointment of the new director, and asked the effect on them of what was known as the New York cable by the West Coast of America.

Mr. Griffith referred to a former fault in the cable, the existence of which had not prevented its working well, and asked why the same means were not used to discover the fault in the Lisbon-Madeira cable? If, however, their electricians were of opinion that it was impossible to discover it, or, having discovered it, to repair it, he thought the wisest course had been adopted.

The Chairman stated that a fault in a cable was a question of degree, and they had acted entirely in accordance with the advice of their electricians. With regard to Mr. Newton's remarks, the right of nominating a successor at the Board was conferred on the directors by the Articles of Association. They all deplored the death of Mr. Chaytor, and in appointing Mr. Brodrick, M.P., to the seat thus rendered vacant they had used their best discretion. Mr. Brodrick would be as useful a director as any other member of the Board. The question of competition in connection with the new company referred to by Mr. Newton had not yet arisen, but the directors had not forgotten the chance of it, or the measures which might in that case be necessary.

Mr. Houston thought that the shareholders should have had another 1 per cent. dividend, and if the directors had transferred £37,000 out of the revenue to the reserve fund, the amount by which that fund would have been increased would have been £50,000 with the dividends received on the investments in which the fund was placed. He also asked if estimates had been taken for the duplication of the Lisbon-Madeira cable, which had been carried out at a cost of £100,000 by the Telegraph Construction and Maintenance Company.

The Chairman, in reply, stated the directors would be delighted to pay 8, 9, or 10 per cent. dividend if it could be done safely. Mr. Houston had said that hopes of larger dividends had been held out, but he (the chairman) went further, and said that those hopes had been realised, seeing that they had grown from 5 to 7 per cent. Consistently with paying what he ventured to call a large dividend, they were endeavouring to build up a fund which would render their property, humanly speaking, as secure as Consols. As he had already said, when further additions to it were unnecessary, they would divide every shilling in dividend.

A Shareholder observed that this question had been thoroughly thrashed out.

The Chairman replied, amid laughter, that they had not the *clôture* at their meetings yet. As to Mr. Houston's other question they had not offered their new cable for public tender, but they nevertheless first ascertained what it ought to cost. He had had a great many dealings with the Telegraph Construction Company, and there was not one which had not been satisfactory. He believed they would agree that where a man or a company did work well, and at the same time as cheaply as it could be done elsewhere, it would be wrong not to continue the employment of that man or company.

In further reply to Mr. Newman,

The Chairman stated that the new cable between Lisbon and Maderia was in no sense spare cable. It had been constructed within the last three or four months. Cables were cheaper now than when theirs was originally

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laid. The reserve fund would be applied solely to the purpose of the renewal of their plant. The resolution was then unanimously adopted.

On the motion of the Chairman, seconded by Mr. Thomas Fuller, Mr. C. F. dos Santos Silva was re-elected a director; as was also Mr. Fred. Youle, on the motion of the chairman, seconded by Mr. H. D. Gooch.

Messrs. H. Dever and J. Gane having been reappointed auditors,

Mr. HOUSTON moved, and Mr. WARREN seconded a hearty vote of thanks to the chairman, which was passed, and the meeting then terminated.

THE J. B. ROGERS ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

The general meeting of this Company was held on the 24th ult., at the offices, Holborn-viaduct, Captain Arthur in the chair.

The SECRETARY (Mr. F. Wisdom) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I regret our chairman, Lord Graves, who came to London yesterday in order to be present to-day, is unable to attend through illness. As most of you are doubtless aware, this is merely a formal meeting, rendered necessary by the Companies' Act, and as it is held at so very recent a date after the allotment of shares, you will hardly expect from me a lengthy statement of what we have done. Our first steps have been directed to ascertaining the best means of conducting the business of the Company, so as to ensure the success we all feel confident awaits its operation, and in that direction our efforts are still tending. Unlike most other electric companies, instead of devoting our time to financial projects, our energies are directed to preparing means to enable us to proceed immediately to the promotion of practical electric lighting, and we are now in a position to undertake contracts for such purpose. We propose at the termination of the lease of these premises to remove to others less expensive but better adapted to manufacturing purposes, and we are of opinion that from them greater profit will accrue. We are in negotiation for several contracts, of which it would be indiscreet of me to mention the particulars, but we are hopeful of success in more than one instance. We have during the past month had a most successful exhibition of the light at Reading, which was a public trial of no mean order, details of which Mr. Rogers, in whose hand, the whole management has been, will now give you.

Mr. ROGERS: Well, the operations at Reading have extended to this: within ten hours we had forty lights, next day we had 105, and then something like 136, and afterwards 189, giving 10 horse-power. I think that is about as much as you can expect from such a trial under the circumstances. We had merely an engine on wheels, nothing fixed, and I believe it was giving great satisfaction in the place. I have since moved to the back of the Town Hall. The town authorities entertain the proposition of lighting up the Town Hall, but it must come before the Council, which meets on Tuesday, November 7. Well, I lit up the Abbey in the first place and the Hall, that is the Abbey Hotel. I also lit up the Ship Hotel and the *Mercury* Office, and gave off lights in two or three shops in the neighbourhood on Saturday night. I also lit up the Queen's Hotel banqueting hall, where the Corporation had their annual banquet. You are quite aware this is only merely to demonstrate the fact that the light is practical, and it was giving the greatest satisfaction in Reading. I think, too, that that is done for about one-eighth per cent. less than was spent by another company in carrying out, or attempting to carry out, what we have in Reading. I think we are doing the best we can with the means at our command.

Colonel LIEBENROOD, in reply to a shareholder, said: I have been at Reading constantly while the experiments have been going on, as I reside in the neighbourhood. I have had facilities for hearing from various sources either good or bad opinions of the different people in the locality, and I can tell you that in every single instance—and I have tried in all parts, parts where I have been unknown to have any connection with the Company—I found the highest opinions were held. Everybody who has seen the light speaks of it as the greatest success he has ever seen connected with electric lighting. I feel quite sure it was a very severe test, because we had to distribute the light over an hotel of three flats. That is a severe test on the distribution of an electrical current, particularly as it is away from our main works, and in a new field. If we succeed here I shall have greater faith in the incandescent light than I have had before. At this exhibition I can say there was not a failure of any kind, and we are told that everybody in the place speaks highly of the light. One or two other companies have tried in the same field before and failed, and they have put it down to a want of power. We have succeeded, and, therefore, we gain all the more credit in having done so.

The meeting was then made special, when the following resolution was put and carried:—That the following Article be substituted for Article No. 95 of the Articles of Association of the Company:—"95.—Notwithstanding any of the clauses herein contained, the directors may from time to time as and when the patents and inventions of the Company or any licenses to use the same shall be sold or disposed of, or granted for any consideration other than the payment of annual royalties, distribute the said consideration among the members in proportion to their interest in the capital of the Company (as nearly as may be), except that the deferred shareholders, in case the dividend mentioned in Article 86, Sub-section 1, shall have been duly paid or provided for, shall be entitled to a distribution of one-third of such consideration amongst them in the proportion aforesaid, and the preferred shareholders shall be entitled to the remaining two-thirds of such consideration for distribution amongst them in the like proportion. For the purposes of enabling such distribution to be made the directors shall be at liberty to sell or realise any part of such consideration which cannot be distributed except by means of a sale, and in the event of any of the members either declining or being unable to accept the proportion of any consideration (other than cash) to which they shall be entitled, the directors may sell or realise the same at their discretion, and pay the net proceeds to such members."

Mr. MARTIN WOOD proposed a vote of thanks to the chairman, which was seconded and carried unanimously.

The CHAIRMAN: I thank you, gentlemen, and hope the next time we meet we may have something more to communicate to you.

The proceedings then terminated.

EASTERN ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

The first ordinary general meeting of the members of this Company was held at the City Terminus Hotel, Cannon-street, on the 31st ult., Mr. Ernest Noel, M.P., in the chair.

The SECRETARY (Mr. J. Marshall Collet) read the notice convening the meeting and the minutes of the last meeting, which were confirmed by the present meeting, and signed by the chairman as correct. The report, an abstract of which has appeared in *The Electrician*, was taken as read.

The CHAIRMAN: Gentlemen, the report itself is tolerably full, and no doubt that to a very considerable extent is the cause of the very small meeting we have to-day. If shareholders are not informed as to the state of a Company, they naturally come to find out what is the state, but it is evident from the very small number of gentlemen who are present to-day that the report of the directors is so full that they did not think it necessary to attend the meeting. At the same time I must confess I am very sorry that more shareholders are not present, as I should have liked to explain to a larger body what is the real position of the Company at the present moment. The accounts, as you see, are only made up to the 30th of June, and when you think of the distance that India is from this country, and that our operations are not confined even to India, but to places, like the Straits Settlements, still further off, you will understand that it would be impossible for us to bring up the accounts much beyond a date like the 30th of June. But still I can tell the meeting something of our position as to our accounts up to a considerably later date, only they would not be absolutely correct, such as we could publish. I may say, too, in my opinion—and I think it is the opinion of the Board generally—that what we hoped for some time ago we find more and more likely to become true. I believe there is a very large opening for the industry in which we are engaged. I believe we may look forward to a successful trade in the East for lighting. Those of you who have at all followed what has taken place in electric lighting in this country must be fully aware that there have arisen very many and grave difficulties as to its application. The mere installation that has been made from experiment has been perfect. Nothing could be more perfect than what we saw at the Crystal Palace (and every one has seen the difficulties that have arisen in this country), but yet you will understand perfectly that there are much larger difficulties in a country like India, where the country is different, and the conditions under which you are working are very different. Many appliances which were perfectly useful for England, or for a country with a climate like our own, were unfit for India, and we had to discover what was necessary, what was useful, what was possible even in a country under these different climatic conditions. But notwithstanding that—notwithstanding that we had to cope with all the difficulties that English electrical engineers had to meet—notwithstanding, I say, that we had all those and our own to boot, we have been making successful progress. We have been day by day and month by month overcoming the difficulties. I do not say that they are all overcome. I do not say we shall not make many and great improvements—I fully trust that we shall—but we have advanced so far that I think we may almost take credit for ourselves in that, beyond, perhaps, any electric lighting company, we have made a definite and distinct progress, and upon that progress I am going to trouble you with a few words. We have sent out to the East and India nearly £40,000 worth of electric appliances of all sorts. I do not know if the shareholders would like me to read the amounts. Of that £40,000 we have sent about £35,000 to India. I am now speaking up to the end of September, not to the 30th June. The items of that I have here. £12,000 was for cable, which I need hardly tell you remains intact; £9,000 for dynamos; £5,700 for a steam engine; £5,000 for lamps; £900 for posts; £800 for carbons; £600 for incandescent lamps, and £1,200 for a variety of things. That is the amount of goods sent out, and which I may say are at this moment as valuable as they were on the day when they were sent out. I believe some of them are more valuable; so that our capital that has been sent forth to different parts of the world remains, though in a different shape, pounds, shillings, and pence. Now, as you would have seen even from that short statement, the chief part of the expenditure was for arc lighting, and you may ask, considering how much has been spent on other lighting elsewhere, why was it only arc lighting? I will speak further on a few words on that subject, and I think you will see that the reasons why we have commenced with arc lighting were such as were dictated by wisdom and prudence. We have already at this moment established in India contracts for about £4,500 a year. That amount is very small compared to what it would have been had we not been interfered with lately, unfortunately, by the Government. The Government prevented us from carrying overhead wires—the only way in which electric lighting of our sort had been profitably carried on till lately; and they interfered not only with what we might have done in the future, but with what we had done, and the successful installations which we had to put up under municipal authority, and for three different towns were arbitrarily stopped by the Government. I am happy to say that the Government has removed that arbitrary interdict against our industry as far as regards what we have done, but they demand in the future that all installations shall be conducted by underground wires. We at once applied ourselves to this; and if the Government do not see fit, even to alter that—which, I think, in all probability they will when they find the installations we have set up have not the grave danger attending them which some of their engineers have informed them there is—when they find that I think we shall find considerable relaxation of the order enforced. In fact, the arguments by which that order was enforced were of such a nature that it is quite possible if there had been a little further knowledge of electric science, and a little further knowledge of what we had done and could do, the whole of that series of objections would have been exploded. But I am free to confess that I am greatly in favour of underground wires, and that they would be far better for us on the whole, with the exception of some places where it is manifest that overhead wires would be the cheapest and the best; but, as a rule, underground wires in towns would be for the advantage both of the

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Company itself as well as for the population. But what have we done? Well, we have a satisfactory contract with the municipality of Bombay, and at this moment we are doing an amount of street lighting which, I think, you would find it difficult to see elsewhere, or at all events to a larger extent. The towns of Broach and Surat have contracts with us for two years, and I am happy to say we are now successfully lighting them up evening by evening. At Broach the rate we receive is £50 per lamp, and at Surat it is a little under that; but both contracts, I may inform the shareholders, are of a paying nature. At Bombay they gave us many facilities, and we have a two years' contract of £1,200 a year for arc lighting, and if that contract is not so paying as later ones, it is still one that is thoroughly satisfactory to the Company. But there are other things that we look upon as still more satisfactory as to our present position. Thus we have got a year's contract with the Kaiser Mill at a very remunerative price—at least, at a fair substantial profit, one that is, I believe, fair to them, as they found it to their advantage, and one that will pay the shareholders. As to that contract, the motive power, which is one of the gravest expenses, is given by the mill themselves, and we have only to supply the dynamos and lamps. For that we have a charge of £28 17s. per lamp per year, and that will certainly fairly remunerate us for our capital employed. What has happened at the Kaiser Mill is already, we learn, affecting two other mills, who, finding what we have done there, are themselves desirous of having the same advantages, and at this moment our managing director is in communication with them. I hope for a telegram within a few days stating that in those two mills we have got an excellent contract signed. On the Bombay and Baroda Railway we have made a temporary installation, showing the great advantages of our system, inasmuch as a break on the line having taken place we were able to send down a temporary installation on thoroughly remunerative terms to us, which enabled the engineer of the line to work by night, so that the line with hardly any interruption has been again opened to the public, showing the great advantage of such an installation; and my belief is that railway companies will find that it is for their own interest to become the purchasers of such an amount of plant as will enable them to supply themselves for such contingencies. Then, again, we have just heard in the last letter from our managing director in India that we are to light up the Viceroy's camp next month, when there will be 50 of our large arc lamps to light up the Viceroy's and the different Punjaub chiefs' camps. That is being done not at our expense, but at the expense of the Government. They are willing to pay us a fair remuneration for this, and I can hardly doubt myself that we shall find, from this short installation, results as to the extension of our industry in this part of the country which will be very satisfactory to the shareholders. Then, that is only one part—no doubt it is the greatest field of our operations; but our operations are not confined to India alone. We originally started in Egypt. There were many difficulties to overcome, but we showed an installation at the Cairo Waterworks which was so satisfactory to the people there that we were about to enter into contracts for larger works. I need not enter into a political disquisition as to what has taken place in Egypt; neither is it in my province to say what will be the future of Egypt, but I think I may say this: that whatever views we have of our present Government we cannot but believe that Great Britain will not retire from Egypt till she has first seen that there is an established Government there. I think, then, I may say if there is a firm Government established in Egypt part of that prosperity will be shared by your Company. I am not going to say much about it, but I have very little doubt that with the establishment of a firm Government in Egypt the Eastern Electric Light Company will also find itself firmly established there. Our agent, Mr. Manod, assures us that he has not the slightest doubt that when we can show a proper incandescent installation as well as that of the arc lighting the demand will be very speedy. I am happy to say that we have secured likewise the services of a very good engineer, who will very speedily proceed to Egypt; and I trust that within a very short time you will see announced in the newspapers that an admirable incandescent installation is to be seen in Egypt, and far better than that, that it is being taken up largely at a profitable price. Again, at Malta we have commenced a small installation. The first one was at our own expense, rather as an advertisement, and nothing more, but after a short time, and seeing what we could do, we had there a short municipal contract, and we have been lighting up the Strada Reale at Valetta. That contract ends, I think, next month, when our agent there, Mr. Rosenbush, informs us there is hardly any doubt that we shall have an enlarged and more permanent contract with the municipal authorities. He also adds that the demand for incandescent lighting—of which I am going to speak presently—is very marked and decided. Then, we have still further than India another field, which, to my mind, promises exceedingly well. First of all we have the great advantage in the Straits Settlements of having in Mr. Judd, the agent of the Eastern Telegraph Company, a most admirable coadjutor, who is permitted to work part of his time for us; and, without again making too many boasts, I think, without hesitation, I may say that your Board now see their way to a good paying business in the Colony of Penang. Again I repeat what I have said before. I said it to the shareholders the first time I ever met them, and I say it again to-day, and I hope to keep it always steadily before the shareholders—what we hope for in this Company is not to make wonderful statements of what we will do, but to bring before you what we have done. You must all know that the difficulties are considerable, but I say that we have overcome many of them, and we can now say that, though we have not done all we could wish, we have done a good year's work in establishing good paying contracts, and in showing what can be done in those distant countries, giving us a good earnest of what will be hereafter. As regards the unremunerative expenses, I think the Board have a right to take to themselves credit for the very small amount of £3,625 that you may put as unremunerative expenses for establishing the work for the first year of the Company. That is like money spent on a building. The building is not the trade. The trade is carried on in it, but you must have a building where you can carry it on. Those expenses of ours, when you consider the distance at which we have had to act, and the expenses we have necessarily had to meet, I think you will say are very small, and they are really part of what we may call capital account, to be dealt with hereafter. It is for the shareholders to say whether it shall be spread over more or less years, but it is certainly more of the nature of capital account than of ordinary expenses. The call that was made of £1 a share, which does not come into this statement, has been well met, and the money so divided is being spent on the inauguration of our incandescent system. And now I am going to say just a few words on the incandescent system; and perhaps you will say, why have you been so backward? When one has heard so much at the Crystal Palace, and other places of what can be done by the incandescent light, why has our lighting company been so backward? I think that a few words will explain that. My belief—and again I hardly like to speak altogether for the Board, but I think I may say fully on the part of the Board that they consider that, while you can undoubtedly on a small installation make the most perfect show of incandescent lighting direct from a dynamo, you cannot economically and commercially work it—at least with our system. I believe that incandescent lighting cannot be worked in a profitable manner, commercially, on a large scale direct from a dynamo. There is the uncertainty of anything happening to your engine, to your dynamo, and to your shafting. If anything happens to any part of your machinery, what happens? Why, your lighting is altogether extinguished, and in the case of a multitude of small lights there is danger, and the expense of watching it is so large that it cannot be done commercially on a large scale. I may be wrong, but we were quite convinced that in our own case it was impossible. I do not wish to speak of other systems. Therefore, storage was absolutely essential, that is to say that you were to have an amount of electricity stored so that you could turn it on like you do gas and water. This company has made an arrangement with the Indian and Oriental Electrical Storage Company, which gives us now the possession, at the cheapest rate at which that company will part with their batteries, and the use of those batteries throughout the whole field of our operations. And what does that mean? It means now that we can send out, nay, that we have sent out, I believe, one of the most perfect installations of incandescent lighting that is to be seen in the world, and I believe that this installation which has gone out to India, and which will land at Bombay in a week or two, will prove to be ahead of almost anything that has yet been shown. The Storage Company are not showing it, but we are only showing what they have accomplished. You may see it at their offices at work—you may see it at your own offices—and if any shareholders have not seen the incandescent system I earnestly invite them to go there and see some boxes that we have brought from Millwall, which are put on a cupboard at our offices, and to see how admirably they work. Every now and then the whole of our offices are brightly and brilliantly illuminated. We are now sending out to India a perfect installation, and we shall have more speedily to follow. We are prepared, within a very few weeks, to send out a good installation to Egypt, and we hope very soon, within a few days, to despatch one to Penang, and not long after that we shall send one to Malta. Mr. Grindle, our chief electrical engineer, starts to-morrow for India, and he will superintend the putting up of this incandescent installation, and happily we have such confidence in him that we have not the slightest fear that the installation will be thoroughly satisfactory both to the people of Bombay as well as to the shareholders of this Company. One of the greatest difficulties that we have had to contend with has been the want of men—of men competent to undertake such work as we have for them to do in these distant countries. I am happy to say, there again, that we are day by day overcoming the difficulties. Men are coming forward. We have in Mr. Grindle, who will be the chief of our electricians in India, a first-rate man. We have other men coming forward, and I hope before I have the honour of meeting you next year that we shall be able to say that we have a first-rate staff working at all parts of what I may call our great Eastern Empire. Now, I do not wish to boast. I do not wish to draw over-coloured statements of what we are going to do. I have tried to tell you simply what we have done, and what it suggests to me. I believe there is a good future to this Company. I believe there is a good future for electrical lighting in the East. I believe it is peculiarly suited to those countries, and I believe we have a system which is day by day overcoming these difficulties, and which will secure to us a large, if not a preponderating portion of this great industry of electric lighting throughout the eastern world. We have not done what we might have hoped, but I have told you that the interference of the Government has seriously affected us. Our managing director tells us that we should have had contracts at this moment of more than £10,000 a year but for that interference, but as it is we have contracts of nearly £5,000 a year. Contracts are coming in daily to us, and the demand for incandescent lighting is such that our managing director there, and our agents elsewhere, tell us that when we can show a really good installation—such as, happily, I am able to announce to you that we can now show—the demand will be more than we can at once carry out. I can only, therefore, say that in my opinion the shareholders of this Company have to be congratulated on what appears to be our hopeful prospects. How rapid the progress will be it is not for me to say. What difficulties still remain to be overcome I do not know, but we are determined to face them, and I believe our past experience gives us a right to hope that we shall overcome them all successfully, and be able to show you that you were wise in embarking your capital in this undertaking. I now beg to move the adoption of the report.

A SHAREHOLDER inquired if any progress had been made by the Company in connection with Calcutta.

The CHAIRMAN: At this moment we are in communication with a firm. I will tell you what we have sent to Calcutta. We have sent a certain amount of dynamos and lamps, but we are anxious not to commence at Calcutta till we can commence arc and incandescent lighting together, because we believe the incandescent is the lighting that will be chiefly demanded, and we should like to have a complete installation when it is made. I hope, however, the shareholders will be informed before long that it will be commenced.

A SHAREHOLDER understood that the Company had an agent at Ceylon, whence he had come. They were badly served by the Gas Company there, and he understood the Company was likely to make some good contracts with the municipal authorities there.

The CHAIRMAN: It is difficult to speak of things in progress, or of negotiations that have not advanced a certain distance. Those that have advanced a certain distance I have told you about. I should not like to say anything about Ceylon except that it has not escaped our attention, and that we are working there.

MR. LATIMER CLARK: I have great pleasure in seconding the motion. I cannot add anything to the remarks of the chairman, but having had

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some considerable technical knowledge of the subject, I fully endorse his observations as to the future of the electric light, particularly incandescent lighting. The field in the East is admirably suited for this purpose. I only wish that the chairman had spoken more strongly about the interference of the Government with the Company's operations. I think if you knew the technical reasons which were advanced against our establishing the light, you would almost feel ashamed of your countrymen. The loss to this Company by this interference has been very severe, and I think the injury has been much more severe than the chairman has stated.

Mr. GILLETT said he had understood from the chairman that the directors were not satisfied as to the commercial success of incandescent lighting—that, although they might be satisfied with the Brush dynamo for the purpose of arc lighting, they were not satisfied that it was commercially successful for incandescent lighting. He thought this might be a serious matter for other companies, and wished the chairman to make a further reference to it. There was a good deal heard about litigation, and he desired the chairman to inform the shareholders the position of this Company as to its patents, more especially with regard to the Lane-Fox patents. He had not heard the name of this Company used in any way as being involved in the litigation, and if that were so he thought it would be satisfactory to all the shareholders to hear that everything they had bargained for was perfectly satisfactory to the directors after the experience which they had had.

The CHAIRMAN: I am very much obliged to Mr. Gillett for the remarks he has made, and am sorry I was so blundering in my expressions as to incandescent lighting that any such idea should have arisen in his mind. What I intended to say was this, that we were convinced that incandescent lighting direct from a dynamo would not be a commercial success. We are not going to have incandescent lighting direct from a dynamo, but through storage batteries, and through storage batteries I believe incandescent lighting will not only be a commercial success, but the very best lighting. I will not say the best and cheapest, though it may be the cheapest eventually, but the very best light ever seen in the world, and will be a complete and thorough commercial success throughout the whole field of our operations. That was the great distinction I made. Incandescent lighting direct from a dynamo is so costly from the immense amount of watching and care required to keep it steady, but directly you are supplied with your store of electricity, which may last as you wish it, for six hours or 60 hours, or much longer, you are free from all those dangers, and from all the expense that is incurred in incandescent lighting direct from a dynamo. As regards Mr. Gillett's question as to some threatened legislation elsewhere I can only say that with respect to this Company there can be no question of litigation. We are, I believe, in a different position from any other company as regards the parent company, inasmuch as we were absolute purchasers of the patents for India and parts of the East, and are manufacturers. We are not a licensed company, but an original company and a manufacturing company. As to the Lane-Fox patents, I give no opinion of them. I can only say if they are not good patents (and I give no hints one way or the other, but we brought them believing they were good, and have no reason to doubt it), it will have no effect on this Company, inasmuch as the money we have paid for them would have to be returned, for the validity of our patents is guaranteed to us. So far as we are concerned, therefore, we have no question of litigation of any sort. If as the outcome of litigation there is any question of the validity of the Lane-Fox patents it will make no difference to this Company except, perhaps, an advantageous one. But I have no right to say that, as it might lead some to suppose that they were not good. Supposing, however, that that were so, you would simply have a little more capital to work with in other directions.

Mr. GILLETT expressed his acknowledgments to the chairman for his reply.

The CHAIRMAN then put the motion, and declared it carried unanimously.

On the motion of Mr. COMBERBATCH, seconded by Mr. W. PAYTON, Messrs. Deloitte, Dever, Griffiths, and Co. were unanimously re-elected auditors.

An extraordinary general meeting was then held "for the purpose of considering, and, if thought fit, passing resolutions rescinding Articles 171 and 173 of the Articles of Association, varying Article 7 by inserting therein after the word 'directors,' in line 1, the words, 'and persons thereunto expressly authorised by the Board, and acting within the limits of the authority conferred on them by the Board,' or making other provision in that article to the like effect; varying Article 114 by inserting therein a provision that no director or officer of the company shall be appointed auditor, and adding a new article to the effect that any resolution or writing signed by all the directors shall be as valid and effectual as a resolution of the Board."

The SECRETARY read all the articles referred to, showing the effect of the proposed alterations.

The CHAIRMAN, with regard to Articles 171 and 173, said: I do not know that either of these is important, but they are objected to by the Stock Exchange, and I think reasonably, and the Stock Exchange require that they should be expunged from our Articles. I think it is rather hard to say that a man should forfeit his shares if, as a shareholder, having a contract, he wished to bring an action against the Company for any non-payment or non-fulfilment of any engagement entered into with him.

Mr. A. M'ARTHUR, M.P., having seconded the motion,

Mr. GILLETT inquired why the two clauses referred to were introduced into the Company's Articles of Association?

The CHAIRMAN: It was a standard form of Articles, and at one time this was not objected to. It is, however, now, and this rule is always cast out of Articles of Association. We did not do so, but we ought to have done so.

The resolution was carried unanimously, as were others in accordance with the notice convening the meeting, including the introduction of a new Article, numbered 95A, as follows: "Any resolution in writing signed by all the directors shall be as valid and as effectual as a resolution of the Board."

The CHAIRMAN explained that it sometimes happened in the autumn that a quorum of the Board could not be got together, without great inconvenience and expense, at a time when it might be necessary that some transaction should be carried out at once. He further explained that under the circumstances indicated, any resolution would be sent to the directors for their signatures.

Mr. MALLET then proposed a vote of thanks to the chairman for his explanation, and at the same time expressed his thanks individually towards all the members of the Board, who had evidently been devoting a great deal of time and attention to the interests of the shareholders during the past year. What the chairman had explained that day must have entailed a large amount of attention.

Mr. COLLETT seconded the motion, which was carried unanimously.

The CHAIRMAN: I am much obliged to you for your kind expressions, and will only say I can answer for the whole of the Board that they will give, as they have hitherto done, their best attention to the affairs of this Company. We do hope to make it a success. We are carefully working for it, and I repeat what I said before, that we have still very good hopes that we shall show a substantial success for your money and our labours.

The proceedings then terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES OCT. 31.		BUSINESS DONE WEEK ENDING OCT. 31. Highest.	Lowest.
Anglo-American	49½,	50½	50	50
Do. Preferred	80½,	81½	81	80¾
Do. Deferred	19,	20	19 15-16	19⅝
Brazil Submarine	12,	12½	12½	12
Cuba	9¾,	10¼	10	9⅞
Do. Preference	16,	17	—	—
Direct Spanish	6,	6½	6½	6½
Do. Preference	15½,	16½	16	15½
Direct United States Cable	11⅝,	11⅞	11¾	11 11-16
Eastern Telegraph	10½,	10¾	10 11-16	10 9-16
Do. 6 per Cent. Preference	12¾,	13¼	13¼	13
Do. 5 per Cent. Debentures, 1899	102,	105	—	—
Eastern Extension	11⅜,	11⅝	11 11-16	11 7-16
German Union	9¾,	10¼	10¼	10¼
Globe Telegraph and Trust Company.	6⅜,	6⅝	6⅝	6 7-16
Do. Preference	12½,	12¾	12¾	12½
Great Northern	12¼,	12¾	12⅝	12⅝
Indo-European	30½,	31½	30½	30½
Mediterranean Extension	1¾,	2¼	—	—
Do. Preference	8,	9	9½	9½
Reuter's	12½,	13	—	—
Submarine	245,	255	—	—
West India and Panama	1⅜,	1⅝	1½	1 7-16
Do. 1st Preference	7,	7½	7½	7½
Western Brazilian	7½,	7¾	7 9-16	7½
West. Union 7 per Cent. 1st Mortgage	123,	128	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Consol. Telephone and Maintenance	1,	1¼	1 13-16	1
Oriental	½,	¾	13-16	½
United Telephone	10¾,	11¼	11	10 7-16

ELECTRIC LIGHT.

Anglo-American Brush	9⅜,	10½	11⅜	9⅝
Maxim-Weston	½,	¾	—	—
Eastern Electric	2¼,	2¾	—	—

TRAFFIC RECEIPTS FOR OCTOBER, 1882.

COMPANIES.	Oct., 1882.	Oct., 1881.	Incrse.	Decrse.
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,000	2,192	—	192
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	—	—	—	—
Eastern Telegraph Company	58,173	48,872	9,301	—
Great Northern Telegraph Company	—	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

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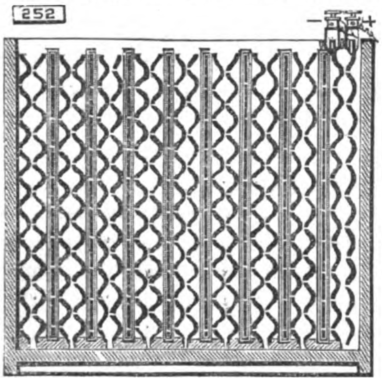
RECENT INVENTIONS.

ABSTRACTS OF SPECIFICATIONS.

252. Improvements in and Relating to Electrical Accumulators, &c., *H. H. Lake, London.—18th January*, 1882.—(*A communication from La Société Universelle d'Electricité Tommasi, Paris.*) 6*d.*

In carrying out this invention each element of the battery is formed of two continuous sheets of ead folded several times and placed in a gutta-percha vessel, in such a manner that a double

252



fold of the one is always contained in a double fold of the other. The sheets are also grooved or undulated, and perforated with holes. To still more increase the surface of the elements, another plate of lead enveloped in lead wire is placed between the two adjacent sides of a fold of the same plate. The battery is illustrated in the accompanying figure.

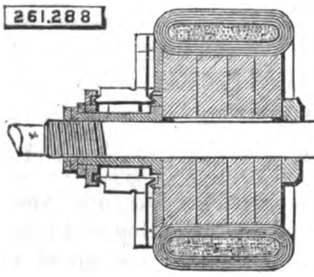
5477. Improvements in Electric Lamps or Lighting Apparatus, *W. R. Lake, London.—14th December*, 1881.—(*A communication from C. F. de la Roche, Paris.*) 6*d.*

The inventer encloses his carbons in a chamber formed within a block of refractory material, preferably calcined magnesia chemically pure and compressed in moulds. The walls of the chamber are also provided with plates of mica to protect the arc from the external air, and to raise the temperature of the air about the arc.

261,288. Coupling for Commutators and Armature Wires, *James J. Wood, Brooklyn, N.Y.—Filed October* 26, 1881.

Brief.—The coupling consists of two parts, one

261.288



of which is attached to the commutator segment, between which the terminals of the armature coils are clamped.

231. Improvements in Telephonic Conductors, *C. W. Siemens, Westminster.—17th January*, 1882.—(*A communication from F. Jacob, on board the ss. Faraday.*) 6*d.*

The object of this invention is to render a number of pairs of telephone wires capable of supplying an increased number of instruments, so that one receiver can be worked for each wire instead of one for each pair of wires as at present. As an illustration, suppose that there are two adjacent circuits, A and B, as at present arranged, each circuit having its battery, sender, receiver, and pair of wires, or four wires in all. The inventor forms an additional circuit, C, with its battery, &c., using the pair of wires of the A circuit for the forward current and the pair of wires, B, for the backward current. He also forms a fourth circuit by using the four wires of the C circuit for the forward current, and earth for the backward current, so that four sets of instruments can be worked on the four wires.

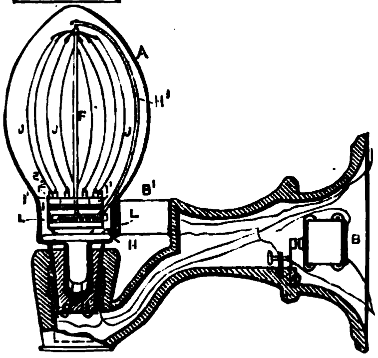
157. Improvements in Apparatus for Electric Lighting, *G. Hawkes, Westminster.—11th January*, 1882. 8*d.*

This invention refers to an arc lamp. The upper carbon holder is attached to the armature of an electro-magnet in the main circuit, which serves to establish the arc. The lower carbon is fed upwards by means of weights. To prevent its too rapid rise a gripping piece is provided attached to the armature of an electro-magnet in a shunt circuit. The tubular holder of the lower carbon is provided with a liquid, such as oil, to regulate the upward motion of the carbon. The inventor also provides the upper carbon with a coiled spring, which surrounds it. This presses on the armature of the electro-magnet, which strikes the arc, and thus counteracts the effect of the magnet to a certain extent, and allows the position of the carbon to be fixed, and also to be maintained. A contrivance for short-circuiting the lamps in case of accident, &c., is also described.

261,503. Automatic Incandescent Electric Lamp, *William L. Voelker, Morton, Pa., assignor to John H. Irwin, trustee, same place.—Filed January* 23, 1882.

Brief.—The interruption of the current by the breaking of a carbon automatically shifts the carbon carrier, so as to bring another carbon into circuit. *Claim.*—(1) In an automatic incandescent electric lamp held firmly in position, the combination of numerous carbon filaments pivoted between supports within the vacuous chamber, one of such supports being provided with an armature, and arranged and adapted to be revolved by an electro-magnet on the outside of said vacuous chamber, substantially as described. (2) In an automatic incandescent electric lamp held firmly in position, the combination of numerous carbon filaments pivoted between supports within the vacuous chamber, one of such supports having an armature and electrical con-

261.503



nections between said carbon filaments, and the electro-magnets B and B¹, and between said electro-magnets, substantially as described. (2) In combination with an automatic electric lamp held firmly in position, and having numerous carbon filaments, adapted and arranged to rotate within the vacuous chamber between supports, one of which is provided with an armature, the electro-magnets B and B¹, of unequal strength, and electrical connections between said electro-magnets and the carbon filaments, substantially as and for the purpose described. (4) In an automatic incandescent electric lamp of the character herein specified, electro-magnets B and B¹, lamp bulb A*, support H, bearing arm H¹, incandescent filaments of carbon J, rod F, disc I, pieces I¹, screws I², and armature L, actuating pawl L¹, the whole combined and arranged to operate substantially as shown and described.

302. Improvements in Voltaic Batteries, *A. R. Bennett, Glasgow.—21st January*, 1882. 4*d.*

For the negative portion of the battery the inventor places an iron electrode packed tightly in iron turnings in a solution of potassium monoxide, or similar solution. For the positive portion, which should be separated from the negative portion by a porous cell, he uses the same solution with an electrode of zinc immersed in it.

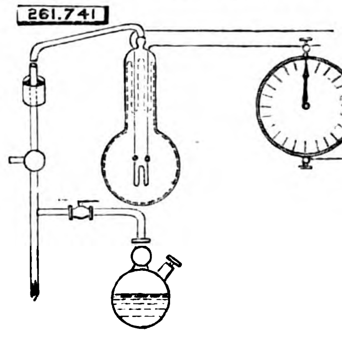
358. Improvements in Sounding Apparatus, *C. A. McEvoy, Adelphi, London, 24th January*, 1882.—(*Not proceeded with.*) 2*d.*

This relates to a means for completing the circuit through a sounding apparatus on board a ship or boat, when a lead or sinker attached to a sounding line, through which runs an insulated wire, shall have made contact with the bottom.

261,741. Mode of Making Electric Lamps and Carbons for the same, *Hiram S. Maxim, Brooklyn, Assignor to the United States Electric Lighting Company, New York, N.Y.—Filed February* 14, 1881.

Claim.—(1) The process of preparing carbons for electric lamps, which consists of, first, removing the occluded gases by means of heat and the air-pump, then subjecting the conductors to a high heat in an attenuated atmosphere of hydrocarbon vapour or other equivalent carbonaceous gas, and afterwards exhausting the surplus gases, substantially as set forth. (2) In the preparation of electric carbons, the cementing and consolidation of the conductors by the deposition of pure carbon from an attenuated atmosphere of hydrocarbon vapour or other equivalent carbonaceous gas, substantially as and for the purpose set forth. (3) The above-described process of regu-

261.741

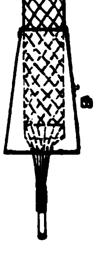


ating the resistance of electric carbons, which consists in heating them in a hydrocarbon or equivalent gas by means of an electric current until their resistance is brought to the required standard, as indicated by a galvanometer acted on by the same current. (4) The hereinbefore described method of making carbon conductors for electric lamps of a standard resistance, which consists in preparing such conductors of an approximately uniform size and of a higher than the standard resistance, and then subjecting them to the action of an electric current in a hydrocarbon or equivalent gas until the resistance is reduced to the required point, substantially as set forth.

261,904. Electric Light Carbon, *Edward J. Brooks, East Orange, N.J.—Filed May* 27, 1882.

Claim.—(1) The combination, with the body of an electric light carbon, of metallic wires in the form of a netting connected with the conducting wire, substantially as herein specified, for the purpose set forth. (2) The combination, in a tubular carbon for electric lights, of internal and external tubular metallic nettings or coatings connected with the conducting wire, substantially

261.904



as herein described, for the purpose set forth. (3) The tubular carbon A, having internal and external wire nettings, in combination with a conducting wire, connected with each of said nettings, substantially as shown, for the purpose set forth. (4) In combination with a tubular carbon having an external wire netting connected with a conducting wire, an insulating holder B, having a hole in its bottom through which the netting wires extend, substantially as herein specified.

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SLIP

South America.—The cable between Mollendo and Callao is now repaired.

Post Office Telegraphs.—Mr. E. Lang, telegraphist at Glasgow, has been appointed postmaster of Cupar-Fife.

Jeddah.—Telegraphic communication with this place is interrupted, the land lines between Cairo and Souakin being broken.

Brazilian Submarine Telegraph Company.—The traffic receipts of this company for the week ended 3rd inst., amounted to £3,446.

Lightning.—During the recent storm and floods which swept over the South of France on the 27th ult., the church at Venanson was struck by lightning.

Eastern Telegraph Company.—We understand this company is applying for a direct wire between London and Glasgow from the Postal Telegraph Department.

Local Government Board Report.—The eleventh annual report shows that the Barrow Corporation has authority to borrow £20,000 for electric lighting purposes, the amount to be repaid in ten years.

West Indies.—The cable between St. Vincent and St. Lucia is now interrupted, as well as that between St. Vincent and Grenada. Telegraphic communication is therefore stopped to the islands of St. Vincent and Barbadoes.

The Military Reorganisation of Egypt.—According to the *Standard's* correspondent at Alexandria the British authorities have fixed on seven permanent military stations, all of which have been connected with each other by telephones.

Electric Lighting of Canterbury Cathedral.—A contract has been entered into by the South Eastern Brush Electric Light Company with the Dean and Chapter of Canterbury to illuminate the Cathedral by the electric light for a period of three months.

A New Cable.—The Eastern Telegraph Company has just completed the laying of a short cable manufactured by the Telegraph Construction and Maintenance Company for the Italian Government. The cable joins the two largest of the Lipari Islands, off the coast of Italy.

Extension of the Telegraph in British Burmah.—The *Bombay Times* states that Mr. Larkins, of the Telegraph Department, was about to proceed, accompanied by 400 coolies and boatmen, to Rangoon and Moulmein, whence it is intended to construct telegraph lines connecting British Burmah with Bangkok, the capital of Siam.

Western Union Telegraph Company.—In the matter of Williams *versus* this Company, a decision was given on Monday last adverse to the recent consolidation with the American Union and the Atlantic and Pacific Companies, and to the increase of the stock from forty to eighty millions. As a result of this decision stock fell from 85⅛ to 82¼.

Electric Lighting in the City.—The special meeting of the Commissioners of Sewers to give effect to the resolution passed as to applying for a provisional order or license to enable the Commissioners to become the undertakers for the supply of electricity under the provisions of the Electric Lighting Act, 1882, will be held on Tuesday, November 21, in order to comply with the Act of Parliament requirement to give one month's notice.

Plating Tin, Brass, &c., with Platinum.—The clean metallic surface is planished and rubbed with a solution of one part platinum chloride, dissolved in 15 parts alcohol and 50 parts ether, and when dry polished in a warm place with a dry cotton or woollen cloth. Bad places in platinum platings may be made good in a similar manner. The coating resembles steel in appearance, and imparts to bronze, brass, or copper utensils a fine platinum surface.

Brighton and the Electric Light.—At a special meeting of the Brighton Town Council on Monday last, it was resolved to apply to the Board of Trade for a provisional order under the Electric Lighting Act, authorising the Corporation, as the Urban Sanitary Authority for the borough, to supply electricity for public and private purposes within their district. The Council had previously resolved to oppose all applications for the licenses by companies.

Kant.—De Quincey, in his essay on "The Last Days of Kant," says that a sign of his (Kant's) mental decay was the weakness with which he began to theorise. He accounted for everything by electricity. A singular mortality at this time prevailed among the cats of Vienna, Basle, Copenhagen, and other places widely remote. Cats being so eminently an electric animal, of course he attributed this epizootic to electricity. During the same period, he persuaded himself that a peculiar configuration of clouds prevailed; this he took as a collateral proof of his electrical hypothesis.

The Maxim-Weston Electric Company.—This company has just concluded an advantageous contract for the sale of their patent rights for the whole of the Australian colonies, New Zealand, and Tasmania, and the first installation will leave this country by next mail steamer. This is the second valuable concession sold by the Maxim-Weston Company within the past few weeks, as the Lancashire Maxim-Weston Electric Company, which has just been floated, has purchased its sole patent rights for that county, Cheshire, and North Wales. It is understood that further arrangements of a similar nature are in progress, by which considerable additional profit will result to the parent company.

Kelway's Electric Log.—The following data give the results of a three days' trial of this log at the Royal Albert Dock, and when taken in connection with the trials we reported last week must be looked upon as very satisfactory:—On November 1 five runs showed a difference between log and mile by mean of means of ·0044, with a difference by mean of runs of ·0041. Similarly November 3, with four runs, showed a difference between log and mile by mean of means of nil, with a difference by mean of runs of ·0075; and November 6, four runs showed a difference between log and mile by mean of means of ·0075, with a difference by mean of runs of ·0150. Dividing in each case by 3 we get the mean difference; it is found to be ·0039 and ·0043 respectively.

Overhead Wires.—Commenting on the answer of the Postmaster-General to Sir H. Tyler's question relating to the recent snapping of a telegraph wire in Cannon-street during a heavy gale, the *St. James's Gazette* remarks:—"The fact that the wire was not the property of the Post Office is satisfactory so far as that department is concerned; but it conveys little or no comfort to the 'metropolitan population and persons using the streets.' If a man has his head cut off or is otherwise mutilated by a broken telegraph wire, it is but scant consolation to him or his surviving relatives and friends to know that the Postmaster-General is in no way answerable for the catastrophe. What people object to is being killed or injured by any overhead wires, whether belonging to the Post Office or not."

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THE LIGHTING OF HELL GATE.—At a recent meeting of the Lighthouse Board, Washington, a report was received from the special committee on the lighting of Hell Gate by electricity, recommending Hallett's Point as the best available site for the electric light tower; also suggesting that a tower be constructed of iron, with a height of 250ft., to contain lights of 20,000 candle-power to be displayed from sundown to sunrise. The report was adopted, and it was ordered that the necessary plans and specifications for the tower and machinery be prepared at once. Proposals for the work will be advertised for as soon as the necessary papers can be prepared. It was also decided that all the machinery to be employed in this tower be duplicated, so that in case of accidents to any part of the machinery it can be immediately replaced.

ELECTRIC LIGHT ACCIDENT.—Much disappointment, says the *Standard's* Vienna correspondent, was created by an accident at Brünn on Sunday night last, where a new theatre was to have been opened, illuminated with the electric incandescent light. It was found that the lead connected with the conducting wires had mostly been melted by the current. A large and fashionable crowd had assembled at the doors of the new building, whom the Burgomaster had to inform that the performance could not take place in consequence of the failure of the electric lights. For a moment, a panic was threatened, but this was averted, and ultimately the crowd separated unhurt, but grumbling at the disappointment. It would have taken at most two minutes to have put in another piece of "lead," so we cannot accept the *Standard's* dictum as to the cause of the postponing the performance.

CLERKENWELL.—The Works Committee of the Clerkenwell Vestry has reported that, pursuant to reference by the Board, they have had before them the applications made by several electric light companies for consent of the vestry to their applying to the Board of Trade for license to supply the electric light to the parish under the provisions of the Act of 1882. It having been proposed to recommend the vestry to oppose the applications of all electric lighting companies for licenses unless they are prepared to guarantee to the vestry, after paying a dividend of 7½ per cent., that one-half of all profits should be given to the vestry towards the reduction of local rates in consideration of the concession granted for laying down their necessary works, the committee resolved that the representatives of the companies making the applications be invited to attend the committee in order to confer upon the subject. The report was approved.

CORPORATE BODIES AND THE BOARD OF TRADE.—The action of most local boards is tending towards obtaining a license from the Board of Trade under the Electric Lighting Act, and so in a manner prevent the annoyance that would arise from the application for a license from a dozen different quarters. We referred to the conference of South London vestries last week, also to the deputations from Birmingham and Sheffield, but many boards have decided to apply for the license. Thus Newington is so to apply; Wolverhampton is to support the company that promises best; Blackburn, Oldham, Bristol, Swansea, the City of London, &c., have approved the application for licenses; Islington will have none of it, nor will Ripon, while Stratford will watch and see that naught likely to be injurious to the interests of the town is obtained by any company. The reports of one or two boards we give elsewhere among our notes, as they are interesting from more than one point of view.

SIGNS OF WEAKNESS.—The *London Gazette* of Nov. 3 contains notices of petitions for the winding up of the Warwickshire Brush Electric Light and Power Company, the Brush Midland Electric Light and Power Company, the Devon and Cornwall Electric Light and Power Company, and the Yorkshire Brush Electric Light and Power Company. We have never hesitated in stating that we thought the eagerness shown by these sub-companies to purchase concessions—or, rather, to open out a field for speculation—was contrary to all teachings of true business; hence, the result as shown by the *Gazette* is not a matter for surprise. If folks can be found to pay for concessions, by all means let them do so; but the general public must be warned to use some discrimination as to what constitutes speculation and what constitutes business. Electric light speculation has been a reproduction in life of the moral attached to the fable of the frogs—"What is fun to you is death to us."

LECTURES TO WOMEN ON PHYSICAL SCIENCE.—*Place*—A small alcove with dark curtains. The class consists of one member. *Subject*—Thomson's Mirror Galvanometer.

The lamp-light falls on blackened walls,
And streams through narrow perforations,
The long beam trails o'er pasteboard scales,
With slow-decaying oscillations.
Flow, current, flow, set the quick light-spot flying,
Flow current, answer light-spot, flashing, quivering, dying.
O look! how queer! how thin and clear,
And thinner, clearer sharper growing
The gliding fire! with central wire,
The fine degrees distinctly showing.
Swing, magnet, swing, advancing and receding,
Swing magnet. Answer, dearest, what's your final reading?
O love! you fail to read the scale
Correct to tenths of a division.
To mirror Heaven those eyes were given,
And not for methods of precision.
Break contact, break, set the free light-spot flying;
Break contact, rest thee magnet, swinging, creeping, dying.

The above is taken from Campbell and Garnett's "Life of Clerk Maxwell."

SOCIETY OF ARTS.—The first meeting of the one hundred and twenty-ninth session of the society will be held on Wednesday, the 15th November, when the opening address will be delivered by Charles William Siemens, D.C.L., LL.D., F.R.S., chairman of the council. Previous to Christmas there will be five ordinary meetings, in addition to the opening meeting. The following papers will be read on the Wednesday evenings before Christmas:—"Refrigeration by Evaporation of Water in Vacuo," by J. Hopkinson, D.Sc., F.R.S.; "The Utilisation of Waste: a Retrospect of Recent Progress," by P. L. Simmonds; "The Artificial Drying of Crops," by William A. Gibbs; "Electrical Exhibitions," by W. H. Preece, F.R.S.; "The Sanitary Inspection of Houses," by W. K. Burton. The first course of Cantor Lectures will be on "Dynamo-electric Machinery," by Professor Silvanus P. Thompson, D.Sc., December 4, 11, 18. The second course will be on "Solid and Liquid Illuminating Agents," by Leopold Field, January 29, February 5, 12, 19, 26, March 5. The third course will be on "The Decorative Treatment of Metal in Architecture," by George H. Birch, April 2, 9, 16. The fourth course will be on "The Transmission of Energy," by Osborne Reynolds, M.A., F.R.S., Professor of Engineering at Owens College, Manchester, April 23, 30, May 7. The fifth course will be on "Secondary Batteries," by Professor Oliver J. Lodge, M.A., D.Sc.

THE ELECTRIC LIGHT IN BRISTOL.—The Great Western Electric Light and Power Company, for which Mr. J. Parsons is the manager, has fixed four arc Brush lights on the premises of Messrs. Jones and Co., of Wine-street. These are of the new pattern, and each gives a light of 3,000 candle-

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power. The electric light should find especial favour with drapers and proprietors of fancy stores, for it entirely removes the difficulty of distinguishing between various shades of colour which other forms of artificial light present. None can doubt this after seeing say a card of many coloured ribbons first illuminated by a good gas light and then with the clear whiteness of the electric arc. The four lamps are intended, to some extent, as an experiment, and the number will probably be increased as soon as their steadiness and utility have been practically ascertained. The same overhead wire which supplies the current to Messrs. Jones and Co.'s establishment serves for an arc lamp outside the XIX. Century boot shop in Wine-street. The temporary arc lights at Messrs. Budgett's new warehouse in Bridewell-street are being removed to make way for the Lane-Fox incandescent lights, which are in a great part of the premises to form the permanent means of lighting. Several arc lights will, however, be retained where a considerable undivided area has to be lighted. The arrangements of the company are carried out by its electrician, Mr. P. Jolin.

The Determination of the Ohm (by G. Lippmann).—It will be remembered that Mr. Joule employed a calorimetric method for the determination of the ohm. The method which I am about to describe differs from that of the eminent physicist in not requiring the quantities of heat to be measured or the mechanical equivalent of heat E to be known. This last point is not unimportant; for in Joule's calorimetric method the final approximation is limited by the uncertainty at present existing respecting the exact value of the number E ; that is to say, the possible error is near $\frac{1}{100}$. The wire of which I wish to know the resistance is placed in the middle of a vessel arranged as a calorimeter in the centre of an enclosure with a constant temperature. An electric current is passed into the wire, and its intensity, i, measured. I wait until, in consequence of the heat liberated by the current, the vessel attains a stationary temperature; I leisurely ascertain that it is so by employing a thermometer, or, rather, a sensitive *thermoscope*, placed inside the vessel. This done, I interrupt the current, and then set in action a motor which produces friction in the midst of the vessel that already contains the wire. The heat evolved by the friction is substituted for that just before evolved by the current. I manage so that the stationary temperature resumes its former value; I then have $ri^2=T$, T being the work expended, whence the value of r. It is scarcely necessary to add that the friction-apparatus must remain in the vessel which contains it, even when it is not in operation, and be furnished with the known arrangements for measuring T. It is also more convenient to commence by the friction experiment, and afterwards to regulate the intensity i so as to recover the same stationary temperature. Lastly, it may be advantageous, for apparatus of large capacity, to replace the observation of the stationary temperature by that of the velocity of the heating. In the form given to it by Joule in 1867, the calorimetric method of the English physicist rests equally upon the measurement of i and the measurement of a mechanical work, namely, the work done at the time of the determination of E. Moreover, it involves two calorimetric measurements, which are to be mutually eliminated from the final result—namely, the calorimetric measurement which accompanies the determination of E, and that which accompanies the passage of the electric current. These intermediate determinations bring in their causes of error and their corrections, owing to the imperfections of the calorimeters employed in making them. I depense with them by taking care to expend the work T and the electric energy ri^2 in one and the same caloriscopic vessel. It becomes as needless to ascertain the quantity of heat evolved in that vessel as to ascertain the weight of the tare in a double weighing; and the advantage obtained appears analogous to that which there would be in replacing two successive single weighings, made with different balances and different weights, by a Borda's double weighing.—Abstract in *Phil. Mag.* from *Comptes Rendus.*

Electrical Engineering.—At the opening lecture of the session in the engineering class of the University of Edinburgh Professor Fleeming Jenkin said that, when closing the class last session, he had spoken of the desirability of having a course of lectures on electricity, and it appeared that it would not be very difficult to prepare a course which would be exceedingly useful to students in large cities. He found, however, that the development of the science was so great that it would be an exceedingly laborious matter to prepare a course on the subject without efficient apparatus; and after his visit to the Electrical Exhibition in London he became more and more convinced that the delivery of such a course without apparatus, and very expensive apparatus, would be simply time lost. Of the immense importance of lectures on electrical engineering he was more and more convinced, and he had come to the conclusion that a new chair was required for its proper teaching. The developments in the science could hardly be exaggerated, and while at one time scientific men were of opinion that the popular mind was expecting too much from electricity, he suspected that the general popular opinion was coming to be about right. The popular mind erred in supposing that electricity would supersede steam as a motive power. What had taken place was that engines were employed to produce electricity, and electricity afforded us the very best means yet discovered of distributing power. Electricity did not take the place of steam, but it took the place of cog-wheels, and of shafting and belting. It took the place of hydraulic machines. Instead of shafting they had a wire from the engine to the machine that required to be driven. It was as a means of distributing power that electricity had become so very important an agent in engineering work. In regard to electric lighting the quality of colour and brightness seemed to him to be matters of exceedingly small importance. In these respects it seemed to be much like a slight change of fashion in dress, the newest style of coat being for a time preferred to the older. But there were numerous advantages to be gained in the carrying on of works which it was impossible to carry on by gaslight; while, for domestic purposes, with the incandescent light they had no bad air and very much less heat than from gas, and this was important from a sanitary point of view. After alluding to many of the uses to which electricity could be conveniently applied—such as the carving of stone, the hoisting of goods, and to farmwork—the lecturer referred to the importance of having technical classes, with suitable laboratories, for instruction in the principles of electric engineering. Touching on the subject of legislation in regard to electric lighting companies, he remarked that every possible obstruction seemed to be thrown in the way of these companies. This, however, might be attended with good in the long run, because electric lighting companies did not seem to be deterred in overcoming those legal difficulties. If anything was to be done at all in the way of studying electric engineering in the University, it must be well done, and ample apparatus must be provided to enable the teachers in Edinburgh to give as good instruction as could be given in any other town in the kingdom.

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A GUIDE TO PRACTICE IN THE SUBMARINE CABLE TESTING ROOM.

VII.

There are in practice two forms of test for determining the capacity of a cable; one is called a test by discharge, and the other by balance. We are only concerned at present with the first of these, reserving the latter for a future occasion, when greater progress has been made. In the test by discharge the quantity of electricity that a cable will accumulate on the surface of its conductor is determined by comparison with the quantity which a condenser whose capacity is known will accumulate under similar conditions. This is found by observing how many divisions on a scale are passed over by the spot of light reflected from a mirror galvanometer when the electricity is discharged suddenly from the condenser (or cable) through this galvanometer's coils. In the same way that conductive resistance is measured by establishing a standard of comparison, which is called an *ohm*, so are we obliged to have a unit or defined standard for capacity, and this is by agreement called a *microfarad*. This is the practical unit of quantity, meaning that it represents a recognised or fixed quantity of electricity; in a somewhat similar sense a quart is a known measure of quantity for liquids.

The subject of electrical units is one that should be studied by the learner, but here we can only offer a few remarks on its simplest aspect that he may get an idea of the measures which he uses in his operations. In business of every kind weights and measures are indispensable, and electrical science must have provision of this kind made for it. Measures of time, length and quantity, and so on, are all founded on an observation of what are called natural laws. They are not arbitrary, and if every one of them in the world were lost or destroyed they are in general easily reconstructed, being exact, and in no sense matters of guess-work or mere calculation. A yard measure, for example, is a stick of a certain length, but that length is determined by reference to the swinging of a pendulum. One that will beat seconds, that is, whose swing occupies one second in a vacuum at the level of the sea and latitude of Greenwich is found to be of a certain determinate length; this is 39·139 inches, but supposing there were no known standards as inches, a pendulum would be found which would swing seconds under these conditions, and the yard measure would be in the proportion of 36 to 39·139, or $\frac{36}{39\cdot139}$ths of that pendulum. Though electricity is non-substantial, it was necessary to have a measure to express quantity, and the name of the great explorer Faraday was given to it. Electricity manifests the properties of attraction and repulsion. In seeking, then, for an intelligent expression of its action in relation to measure, we are guided by the exhibition of its properties—just as we know to have been done in the example above given. Here is this invisible and impalpable *something* called electricity—how can we reduce it to measure? The answer is, by observing what it does or what happens when it is manifested. It is usual to give as the easiest example of a reference to what are called "absolute units" the expression for velocity. What is velocity? Simply a ratio or relation between "time" and "length" (which are absolute in the sense of being fundamental; they are foundations on which various units or standards are built). Thus, velocity is so much length passed over in such a time. So with electricity, such a quantity repels an equal quantity of a similar kind with a certain force when placed at a certain distance from it; in other words, a unit quantity repels a similar and equal quantity with unit force when at the unit of distance. Quantity, therefore, has relation to force and distance, and capacity is quantity raised to a certain potential. To use the expression "a quantity of electricity" means nothing definite unless its potential is stated. We have already roughly set forth what this is in No. II. of this series. A "farad" is a certain quantity raised to a certain potential by a certain force, but in practice this would be inconvenient as constituting a condenser of enormous size; so the thousandth part is taken, and the measure is a "microfarad." It must be understood that these so-called "measures" are merely convenient vehicles for the expression of known laws, and as far as being able to test correctly and furnish intelligible results as to the electrical qualities of a cable, and consequently its excellence as a signalling agent, the operator may safely content himself with knowing the names and relation of the electrical units which have been devised for him.

The condensers in use are generally $\frac{1}{2}$ or $\frac{1}{3}$ microfarad, and to this instrument as a standard the cable is to be compared.

We will now look at the arrangements for the test, and consider the various parts of the necessary apparatus; in so doing it will be necessary to give a few detailed explanations about the keys and connecting pieces, which will apply to other tests besides that for capacity, since the same appliances are used for different purposes, and the leads between them are mostly permanent.

First, we have our condenser. The two poles are separated by a plug hole, with a plug for convenience of uniting them when the instrument is not in use. Care should be taken that in these intervals the plug is inserted, the object being to keep both poles at the same potential, namely, that of zero. There should not be any remains of electrical charge in either side, and the best way is to keep the plug in and connect one pole also to earth; but the earth wire is a disadvantage if the plug is not inserted. When about to use the condenser, therefore, it is advisable not to withdraw the plug till just before charging. Ten cells are generally used for the test, and a battery commutator is commonly fixed near the key, &c., for convenience of changing the number of cells for different tests. In the Fig. 13 this commutator is seen above the battery, and the leads from the battery poles are brought up

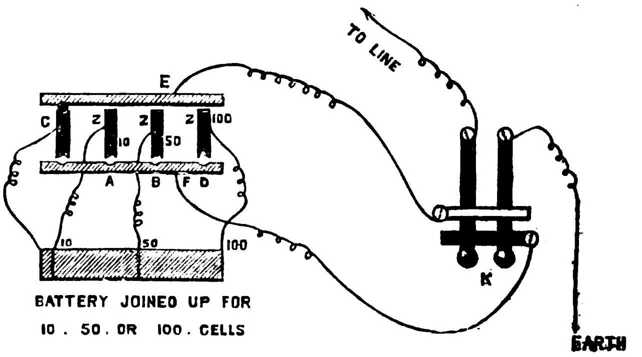

Fig. 13.

as shown. One lead only is connected for the copper pole, and is never shifted; leads from the zinc pole of the 10th, 50th, 100th cell, or according to what particular power is required at any time, are connected to Z, Z, Z in the commutator, and each can be used separately at need by plugging in at A, B, or D. As long as no plug is inserted at any of these points there is no communication with the key K. It is seen that this is connected by one lead to the bar E, for copper, and another to F for zinc. Each piece can be joined to the poles at will. The battery key is of the ordinary form called a double current key, and used for all tests (see K, Fig. 13). Two of the four terminals are always used for the battery, and the other two for line and earth. "Line," of course, means the cable or condenser, or anything under test. It is necessary to have a commutator also between the key and the galvanometer and cable for the purpose of controlling the direction of the current through the coils enclosing the mirror and magnet, and consequently influencing the deflection either to the right or left hand on the scale. The most convenient method is to have connecting pieces, to be joined at will by plugs. The ordinary form of commutator is shown in principle in Fig. 14, the only difference from the reality being that each of the four quadrants is mounted on an ebonite pillar for insulation. With two plugs the current can be variously directed, and a third is required to short-circuit the galvanometer when charging or discharging if necessary. Two of the terminals, as A and A^1, are for the leads to the galvanometer, and the other two, B and D, are for the leads to the cable and battery key respectively. A moment's consideration of the result of varying the plugs

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when a battery key is joined up with this commutator will be useful and prevent confusion if borne in mind. Fig. 14 also shows a double-current key as generally connected. It is usual to join up all the battery keys in the room in the same way—for example, the left hand terminals of the various keys will all connect (say) to zinc battery pole and earth respectively, and the right hand terminals to the copper pole and line. We always know, therefore, how the leads go. In the figure the key is thus connected. We call the point L the line terminal, though not going direct to the cable, but through the point D in the commutator to it either way round. If now a current from the zinc or negative pole is passing through the arrangement, including the galvanometer, and the plugs in the commutator are in the position I, it will start from Z through L, then through D and A, and enter the cable at B; but the galvanometer is short circuited by the plug between A and B leading direct to A^1, and will give no deflection, the current preferring the path of least or no resistance. On taking out this plug the path will be through A and by the lead to the galvanometer, through this and by lead to A^1, and then through the cable. Let the plugs now be as in position 2, the third plug being taken out from between A and D; then the current will go by lead to D, and through the galvanometer in the reverse direction by A^1 to A. The deflection on the scale would be, say, to the right in the first case, and to the left in the second. If the other battery key were depressed, namely, that having the earth wire on its end, and a "positive" current employed, the direction of the deflection on the scale would be right or left, according to the arrangement of the plugs; but with this current the direction would be reversed in the case of each of the above two positions. For a so-called *negative* current is merely a positive current going in the reverse direction, and the course through the commutator and galvanometer and cable would be from the earth. It is best to regard the battery as producing one current only, starting from the copper pole, and going either to earth or line according to the connections. The learner will see from a consideration of the figures that it is easy to make the galvanometer deflection be on either side of zero (which is at the centre of the scale) at will. It is often convenient to keep it on one side when changing the current, and later on it will be seen that this facility is necessary for purposes of correct experiment.

Other forms of commutator are often used in the place of that here suggested, but the principle is the same in all, or, rather the desired object is alike secured by all, though by different means. That shown in the figures is a four-way piece, and any efficient substitute for it may be similarly named. Our battery key is a four-way piece also, and might be used for the purpose. This will be illustrated later on.

Besides the battery key another key is generally used, though it can be dispensed with if desired. We can thus take this test in two ways, and shall give two figures showing the connections. The form of key is a matter of taste, as they are variously constructed, but the so-called trigger key is more generally used. This will be shown in the figure representing its employment for the capacity test. Perhaps the learner may find another form of key in practice, and it may be what is called a "Lambert's" key, from the inventor. This is outlined in Fig. 15, and it has three connecting terminals, as also has the trigger key. We give this figure here to avoid taking up too much space with repetition of connections. When the test with the trigger key is considered the student can easily see how the Lambert key can be substituted for the other. In Fig. 15 the cable is joined to G, the battery to H, and the galvanometer to J. Thus the cable can be separately connected to either of the two latter.

Before actually taking this test we have one more appliance to consider, namely, a shunt. We have already referred to this in No. III. of this series, and have explained it to be a means of relieving the galvanometer of part of the current or charge. The effect of charging the condenser, or cable, through the galvanometer without using a shunt would be to cause a swing of the little mirror, which would throw the reflected spot of light beyond the end of the scale. We must therefore have a shunt of such resistance as will give us a readable deflection—that is, that will lead away such a proportion of the charge as would be more than sufficient to allow the spot to show itself on the scale, when at the extreme point of its flight, remembering that, if we do this, we must afterwards multiply the visible deflection by the multiplying power of the shunt, or that figure representing the proportion in which the galvanometer charge has been lessened. An ordinary resistance box consisting of coils of various resistances from 1 up to 5,000 units is generally used for the purpose, and shunts of any required resistance can be thus brought into circuit. The rules for finding the multiplying power of a shunt are governed, of course, by the principle of its action, but at present we omit this part of the subject.

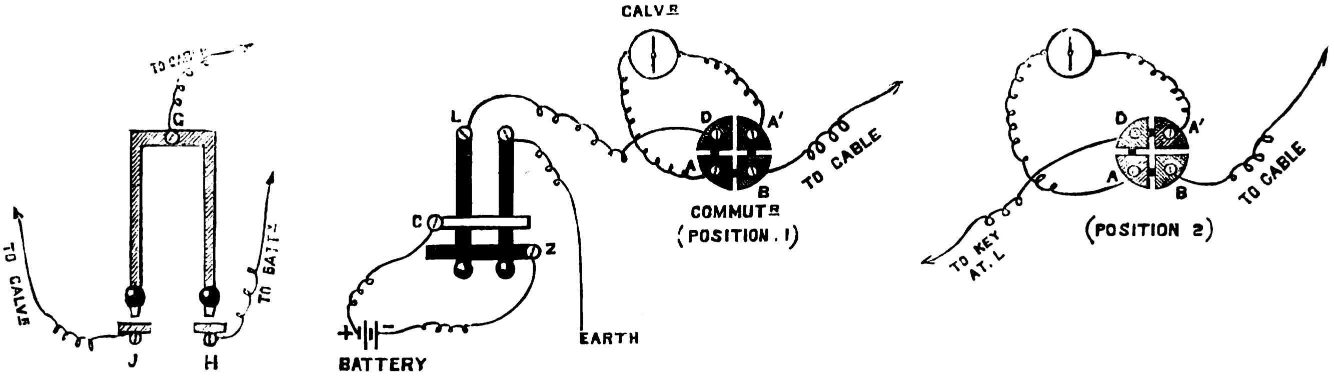

Fig. 14.—Skeleton "Lambert" Key.

Fig. 15.

It is only necessary at this point to know what it means, and to remember the necessity for considering the multiplying power.

THE EARTH AS A RETURN CONDUCTOR.

BY OLIVER HEAVISIDE.

The daily newspapers, as is well known, usually contain in the autumn time paragraphs and leaders upon marvellous subjects which at other times make way for more pressing matter. The sea-serpent is one of these subjects. This year, however, that interesting animal has not been so observable, which is, perhaps, the reason why an equally wonderful and not less time-honoured phenomenon has come to the fore again. There appeared lately an account of the performance of "an innocent boy" with a stick of wood, which, being held in the hands of the operator as he walked about in a field, twisted and turned itself so as to prove the existence and point out the situation of water beneath the surface. This may or may not be. Never having studied the action of divining rods makes me an incompetent judge; but on further reading the explanation of a philosopher of the cause of the phenomenon, viz., that the water was a conductor of electricity, and, therefore, the electric currents deflected the wand, I was at once reminded (perhaps strangely, for there is hardly any connection between the theories) of a theory of the action of the earth as a return conductor that I first read some fifteen years ago in a handbook which has since passed through many editions.

It was to this effect: that if two insulated conductors were

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connected to the poles of a battery, a certain quantity of electricity would pass to charge them; that the larger the conductors the longer time the charging would take; and, finally, that if they were infinitely large, it would take so long that the current would pass as if the poles of the battery were directly connected. The application of this theory to the earth's circuit was that the earth was practically infinitely large, and so the current passed continuously.

Both the theory and its application seem erroneous. For, by the laws of electrostatics, the charge the two insulated conductors would receive would depend upon the size of their opposed surfaces, and upon their proximity, but not upon their bulk *per se* at all. If we had two worlds side by side, and joined them by a wire with a battery inserted in it, quite a small quantity of electricity would suffice to charge the system; and if the bulk of the auxiliary world were increased indefinitely on the side furthest from the real, it would make scarcely any difference. The way to increase the charge would be to make the second world surround the first, and bring it as close as possible, when the capacity would be greatly increased, though not to any such extent as to give rise to a permanent current.

And the application of the theory to the case of the earth is faulty, because although it may be regarded for certain purposes as an infinitely large conductor, yet it is only one conductor, not two conductors insulated from one another.

There seems, in fact, no hypothesis at all wanted to explain why, when the ends of the wire containing a battery are put to earth, the current continues to flow. The earth is a conductor, and completes the circuit, and what more is wanted? It would be very extraordinary if the current did not continue to flow indefinitely, or until the battery got used up, or a disconnection occurred somewhere. The very existence of such a theory, however, shows that there must have been considerable doubt as to the real action of the earth.

Another theory, a very popular one, is much more satisfactory. The earth is so large, and contains so much electricity, that it may be regarded as an infinite store, to which all charges we may add or take away are utterly insignificant. Allied with this is the theory that compares the earth to an immense reservoir of water, or the sea. We may pump out or pour in as much water as we please without making any appreciable difference. This last form, by proper limitations, has the advantage of being easily converted into an exact analogy.

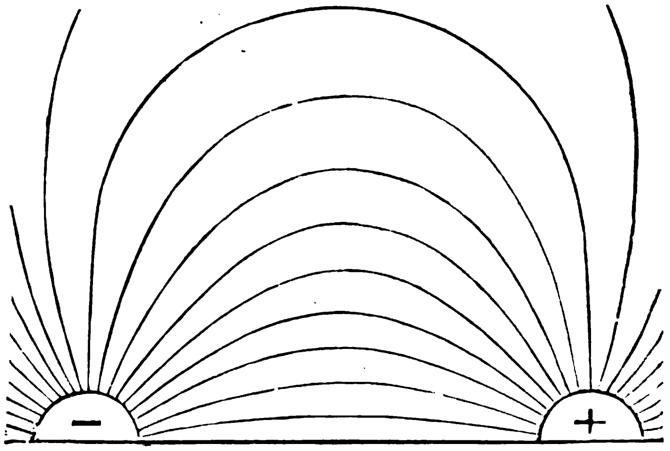
Let there be a reservoir of water, large or small, and let the water be completely enclosed on all sides in a tight-fitting envelope, so as to completely fill it. Let, further, the water be absolutely incompressible, instead of nearly so, and let a pipe, also completely filled with water, make connection between two parts of the reservoir, where of course are corresponding openings. We have then a quantity of fluid occupying a certain space, and which must always continue to occupy the same space. Set the water in the pipe in motion, then it follows that the current crossing every section of the pipe is the same, that an equal current leaves the pipe at one end, and at the same time an equal current necessarily enters the pipe at its other end. Furthermore, the lines of flow of the water in the reservoir itself are perfectly definite, depending only on the shape of the reservoir and the position of the pipe terminations, or source and sink.

For the reservoir of water substitute a conductor of electricity of the same size and shape, and for the pipe a conducting wire similarly terminated conveying a current of electricity, and the analogy is quite complete, so far as *steady* currents are concerned, and the lines of flow of the electric current are the same as those of the real fluid in the former case.

In fact, for purposes of analogy, we may regard the earth and a wire joining two points of it as being always filled with electricity, whose quantity may be as small or as great as we please, and that it is incompressible, and must follow the same law of continuity as a real, incompressible fluid, if such existed. Such hypothetical electricity would not, however, be the electricity of the definition $\frac{e_1 e_2}{r^2}$ = force between two charges e_1 and e_2 at distance r, because it has no statical action. Statical actions do occur, owing to surface charges, but we have no concern with them here, only the current under consideration.

Or, without any hypothesis as to the univeral existence of the electricity, simply regard the conductors (wire and earth) as being capable of bearing at every point an electric *current*, simply subject in its distribution to the law of continuity of an incompressible fluid. There are other quantities in physics having the same property, and there is no occasion whatever to consider electricity as a fluid at all, except for purposes of illustration.

Although the mere size of the earth has nothing to do with the permanent flow of the current, it has an important influence upon the resistance and lines of flow. To study the matter more in detail we may start with the simplest case imaginable, a long thin wire buried in an infinitely extended conducting mass of uniform conductivity, the wire being, of course, insulated except at the ends, which we may suppose terminated in spherical electrodes. Let there be a steady current, C, in the wire. A current, C, leaves the + electrode and enters the − at the same time. Considering one electrode only, say the + (let, for the time, the − be at an infinite distance), then, owing to symmetry, the current C spreads out equally in all directions, so that its strength is $\frac{C}{4\pi r^2}$ at distance r from the electrode, and is everywhere radial. (This is the current density, or current across unit area perpendicular to lines of flow.) The lines of flow are straight lines, starting from the electrode and uniformly distributed.



The same is true for the − electrode, except that the direction of the current is to it and not from it. And to get the lines of flow in the real case of finite distance between electrodes, we have only to find the resultant of the two systems. At a point distant r_1 from the + and r_2 from the − electrode, the current density is the resultant of $\frac{C}{4\pi r_1^2}$ in direction r_1, and of $-\frac{C}{4\pi r_2^2}$ in direction r_2.

In the neighbourhood of the electrodes the lines of flow are, as before, straight, radial, and uniformly distributed, but all the lines from the + ultimately curve round and join those belonging to the − electrode.

The distribution of lines of flow is the same as that of the lines of force between two small spherical conductors with equal opposite charges, or as the lines of magnetic force between the two poles of a long, thin solenoidal magnet.

It is easily seen that the form of the electrodes is of no importance so far as the lines of flow at a considerable distance from them are concerned, and it is only near them that changes in the form of the electrodes must alter the lines of flow. We choose spheres for simplicity.

Observe that there is no current *across* any plane section through the electrodes, and that such a plane separates the current system into two symmetrical halves. We may therefore take one of these halves, completely disregarding the other, and we have the correct distribution of lines of

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flow in the case of two hemispherical electrodes with their flat sides flush with the plane surface of a conductor infinitely extended on one side only. This conductor we may consider as the earth, and the electrodes the earth plates, to which a wire conveying a current C is connected at the ends. Then, presuming uniform conductivity of the earth, the current density at distance r_1 from the + and r_2 from the − electrode is the resultant of $\frac{C}{2\pi r_1^2}$ along r_1 and $-\frac{C}{2\pi r_2^2}$ along r_2. (We have 2π instead of 4π, on account of the one-sided radiation.)

We may also easily find the form of the lines of flow when the electrodes are buried at some depth from the surface. We have only to double the system by introducing another earth above the real, with electrodes in it to correspond, as much vertically above the plane of reparation as the real ones are below it—images of them, in fact. We have then two + and two − electrodes in an infinite conductor, and the system of lines of flow is the resultant of four radial systems; and since the plane of separation has no current across it, the lines of flow are unaltered in the lower system when the upper is removed. Thus in the real case of buried electrodes the lines of flow are deflected by the surface of the earth in the same manner as if the images had a real existence.

Similarly, we may find the lines of flow for any system of electrodes by superimposing the different elementary systems, employing images when necessary.

Resistance of Earth.

A wire being put to earth at its two ends, the resistance of the circuit formed may clearly be separated into three portions, that of the wire right up to the electrode (with which we have nothing here to do), that of the electrode itself, and that of the earth between the electrodes. The last may be readily found.

Imagine a single spherical electrode, say +, of radius a, in an infinite conductor of specific resistance K, supposed uniform, *i.e.*, K = resistance per cubic centim. In consequence of the uniform diffusion of the current, the equipotential surfaces are concentric spherical surfaces, and the resistance between any two of them of radii r and $r + dr$ is

$$K \times \frac{\text{thickness}}{\text{area}} = \frac{K\,dr}{4\pi r^2}.$$

Therefore, if R is the whole resistance outwards from the electrode,

$$R = \int_a^\infty \frac{K\,dr}{4\pi r^2} = \frac{K}{4\pi a}.$$

In the case of the earth, with hemispherical electrodes of radii a_1 and a_2, the resistance between them is

$$\frac{K}{2\pi a_1} + \frac{K}{2\pi a_2}. \quad . \quad . \quad . \quad A.$$

But if the electrodes are spherical, and deeply buried, the resistance is

$$\frac{K}{4\pi a_1} + \frac{K}{4\pi a_2}. \quad . \quad . \quad . \quad B$$

nearly.

In A the resistance is double that of B, on account of one-sided diffusion, and in both we add the resistances calculated for each electrode separately, because it is practically confined to their neighbourhood. And this is why in B we have 4π, the same as for an infinitely extended conductor.

To exemplify this point—the distribution of the resistance—compare the resistance between a and $2a$, $2a$ and $4a$, &c., for one hemispherical electrode.

Between $r = a$ and $r = 2a$,

$$R \doteq \int_a^{2a} \frac{C}{2\pi r^2} = \frac{C}{2\pi}\left(\frac{1}{a} - \frac{1}{2a}\right) = \frac{1}{2} \cdot \frac{C}{2\pi a}.$$

Similarly, between $r = 2a$ and $r = 4a$, the resistance is $\frac{1}{4} \cdot \frac{C}{2\pi a}$, and from $r = 4a$ to $r = 8a$, it is $\frac{1}{8}\frac{C}{2\pi a}$. Now, $\frac{C}{2\pi a}$ is the whole resistance, so one half of it lies between a and $2a$. It may be easily shown that about 99 per cent. lies between a and $100\,a$, and the remaining 1 per cent. beyond.

The difference of potential between two electrodes is, of course, R × C, where R is the total resistance between them. It is customary, and generally convenient, to consider the earth as being at the same potential; but of course the return current could not flow if such were really the case.

As regards the amount of resistance, it depends essentially on the size of the electrode in the first place, varying inversely as its radius; so that it may be as great or as small as we please from this cause alone. And it is directly proportional to the specific resistance K. Thus (hemispherical), with a radius of 1 metre, the resistance is $\frac{K}{628}$. With $a = \frac{1}{2\pi}$ centim., and K = 1 ohm. R is also 1 ohm. Even with a spec. resistance of 1 megohm, we can bring the earth resistance down to 1 ohm by taking the radius of electrode = 10^6 centim., or nearly 1 mile.

Naturally, we may include the electrodes in the earth resistance by letting the end of the earth wire be the electrode; then we see that from its smallness the conductivity immediately around it is a matter of the greatest importance, and since common earth is badly conducting, the utility and necessity of "earth plates," whether plates or not. Also, that around the earth plates for a considerable distance the conductivity is of importance, and we cannot get a good earth in a rock without very large earth plates. But as we proceed further away the conductivity becomes of less and less importance, and we may say that it hardly matters; with this proviso, that the very badly conducting material does not completely shut off one electrode from its fellow at the other extremity of the line wire. The earth may be perfectly insulating for hundreds of miles, and the current will go round the impermeable mass with no sensible increase of resistance. In the extreme case of a non-conducting screen, only leave a practicable opening in it, and the total resistance of earth will be merely increased by the resistance of the matter in the opening, and a little way on each side where the current converges. If the non-conducting screen were quite complete no permanent current could flow from one electrode to the other, and signalling would have to be carried on by transient currents, the two sides of the screen forming the two poles of a large condenser. Such a case is hardly likely to arise in practice.

DUNDEE.—The following letter is a little instructive, and shows that the actions of interested parties are criticised by the outside public. The letter appeared recently in the *Dundee Advertiser*:—"At the recent meeting of the Dundee Gas Commissioners, Mr. M'Crae, the gas manager, presented a report on the subject of electric lighting, recommending the Commissioners to adopt as their scale of charges in supplying customers 1s. per hour for arc lamps, and 4d. per hour for incandescent lamps. I have had the curiosity to ascertain how this charge would compare with the contract prices arranged for by the local electric light company and some of their customers. I find that the local company are under contract to light, with 18 arc lamps, the Fine Art Galleries during the three months the exhibition remains open. The light will be in operation in all about 200 hours. At 1s. per hour the cost per lamp would thus be £10, or for 18 lamps £180, but the contract price with the local company is only £75. More striking still is the difference in the case of incandescent lamps. One of the recent contracts of the local company is for 70 incandescent lamps, to burn on an average 1,250 hours each during the year. The contract price is £86. Taken at the rate recommended by the gas manager, each lamp for the year would cost £20 16s. 8d., or for 70 lamps no less a sum than £1,458 6s. 8d. After a comparison of these figures, I may ask whether it would be for the public advantage for the Gas Commissioners to have a monopoly of a light which it is clearly not their interest, as makers of gas, to see generally introduced?—THE ELECTRIC SPARK."

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 396, Strand, London, W.C.

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All letters intended for insertion in THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.

The Society of Telegraph Engineers and of Electricians, which began its winter session last Thursday evening, has work before it of more than usual interest and importance. We are not in the secrets of the Society—if there are any—and we do not in the least imply that the work we allude to is going to be done. What we do mean is that the time is favourable for great things, and that the public, who are interested in its proceedings, will expect some, at least, of these things to be done.

Foremost among them is the question of electric lighting. This is at once a most pressing and most difficult matter to handle. If the Society neglects to deal with it as it ought to be dealt with, the Council will incur the reproach of disregarding the public interests now so greatly occupied with the subject. On the other hand, if an attempt be made to supply the world with trustworthy information, it must, at the best, be incomplete and inadequate. No trials on an extended scale have yet been made for a length of time sufficient to predict the results, and calculations based upon theoretical data have already lost the confidence of the general public. Then, again, there is the difficulty of getting, we will not say an honest, but a disinterested person to deal with the subject in a competent manner. The demand for professional assistance among the multitude of companies promoting electric lighting has, it may be feared, left us hardly anybody perfectly free to speak his mind, and information from any such quarter would be much discounted beforehand, even though the authority were a paragon of candour and single heartedness. One of our cleverest statesmen, whenever he was pestered with conflicting suggestions as to what ought and ought not to be done, used to say, "Why do anything? Let it alone." That statesman is now dead, and we no longer live in an age when the let-alone maxim is tolerated. Among the many people who have reason to regret the change may be safely included the Council of the Society of Telegraph Engineers at the commencement of this present session.

A good opportunity arises for the Society to take the initiative in formulating precise data relating to matters connected with electric dynamos and other similar appliances. There are several different kinds of dynamos for example, or, rather, we should say, they are worked on several different principles. What are the practical results of this difference is a matter not difficult to state, but one which, so far as we are aware, has not yet been set forth by any authoritative body. With the question of electrical units the Society will also be tempted to deal. This has been taken up by the Paris Congress in a way which we cannot regard as quite satisfactory. At that Congress, as at the Congress on Cables held in the same city, England, though represented, is not consulted. Decisions arrived at in this fashion can only be acceptable by mere accident, and cannot be called international at all. Its recommendations will be treated respectfully, but they ought to be subject to discussion and rectification if necessary.

The difficulties which beset the question of electric lighting do not extend to the discussion of electrical storage; and on this, at least, the public will think they have a right to be informed without reserve. A great deal of public money has been stored in the new battery, and the depositors are anxious to know what amount of pecuniary energy is likely to come out of it. A perfectly candid opinion from an authority like the society we are alluding to would be of extreme interest just now, and might astonish a good many people—especially if it appeared in the Society's *Journal.*

The matter of overhead telegraph and telephone wires is becoming every day of more and more importance. It is true the Society of Telegraph Engineers cannot directly interfere. The municipalities, for the most part, are responsible, and are the only persons competent to legislate. But the municipalities cannot confiscate property, even though it endangers public safety. Something very startling would have to occur before wires could be ordered down wholesale, and we do not want this startling occurrence to happen. The case would be different if a cheap and efficient method of underground wiring were devised. Having something to fall back upon, the municipalities might then very well say to the offending companies, We require you now to place your wires where they shall cease to threaten human life, and be no longer an offence both to eyes and nerves. This, we think, the Society ought to enable local authorites to say, by giving the experience of the best systems of underground wires at present in use.

A society which has been so largely identified with telegraph engineering will one may imagine, take a lively

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interest in the proceedings of the Cable Congress now sitting at Paris. It is to be hoped that a thorough discussion on the relations of submarine cables to international interests may not be too late to influence the final decisions of the Congress.

Electrical exhibitions are now becoming of such common occurrence that a discussion of their respective merits would seem almost to be superfluous. Nevertheless, in the case of foreign exhibitions, the advantage of having the newspaper accounts supplemented by competent representatives of a technical society is considerable, and the address which Mr. Preece was announced to deliver last Thursday on the Electrical Exhibition at Munich furnishes an example of how this may be very usefully done.

CORRESPONDENCE.

A TELEGRAPH LINE WITHOUT INSULATORS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read with the greatest interest a letter under the above title from Mr. James V. Fry in your issue of October 28th.

From it it appears that that gentleman has discovered how

(1) To dispense with insulators on a telegraph line, and

(2) To make a voltaic battery with no stronger chemical than pure rain water.

As a telegraph engineer, with some knowledge and experience of insulators of porcelain, stoneware, glass, and ebonite, such as were designed by Varley, Clark, Siemens, Opperheim, Bright, Chauvin, Cordeau, Brooks, and other erring electricians, under the delusion (for so Mr. James V. Fry has shown it to be) that electricity, like a fox, had an inconvenient knack of running to earth, and of the batteries of Daniell, Grove, Bunsen, Thomson, Leclanché, &c., in all of which chemicals somewhat stronger than pure water are employed, I should like to ask how the 200 miles (I presume Mr. James V. Fry has not written miles in mistake for mils.) of uninsulated line worked during rain (of course, there was rain in Japan, or where would the chemicals for the Fry battery come from?), and when the dews of Heaven (if such exist between Nagasaki and Shimonosaki Straits) were refreshing the earth, and also to inquire as to the reaction of the Fry cell and its electromotive force. Pure water is stated (obviously in error) by several eminent chemists, whose works I have consulted, to be an extremely poor conductor of electricity, and I am consequently curious to glean some particulars of the internal resistance of the Fry batteries.

Altogether Mr. Fry's discoveries seem to stamp him as one of the rising electricians of the day, and I only trust that adequate steps have been taken to receive by letters patent the golden fruits of his philosophy. I may say that I am arranging with Mr. Wragge for a supply of pure water from the summit of Ben Nevis wherewith to construct a Fry battery, and that I shall endeavour to persuade a friend of mine in the Highlands who possesses a telephonic wire to allow me to remove the insulators (which indeed, are worse than useless, as they are sometimes broken by boys, to the detriment of the communication), and replace them by staples—I presume turned or galvanized iron staples will do—and I shall have much pleasure in communicating to you, Sir, the results of my experiments.—Yours truly,

M. Practical.

RESISTANCE BOXES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In regard to the resistance box described in your issue of September 30, I would like to draw attention to the fact that a patent was taken out in 1852, No. 212, by T. Slater and J. J. W. Watson, "where iron wires of different thicknesses are imbedded in pipe clay, or alumina, or asbestos." The current enters by all the wires, and leaves by a movable contact piece that can be connected to any one of them. I enclose my card and beg to subscribe myself as

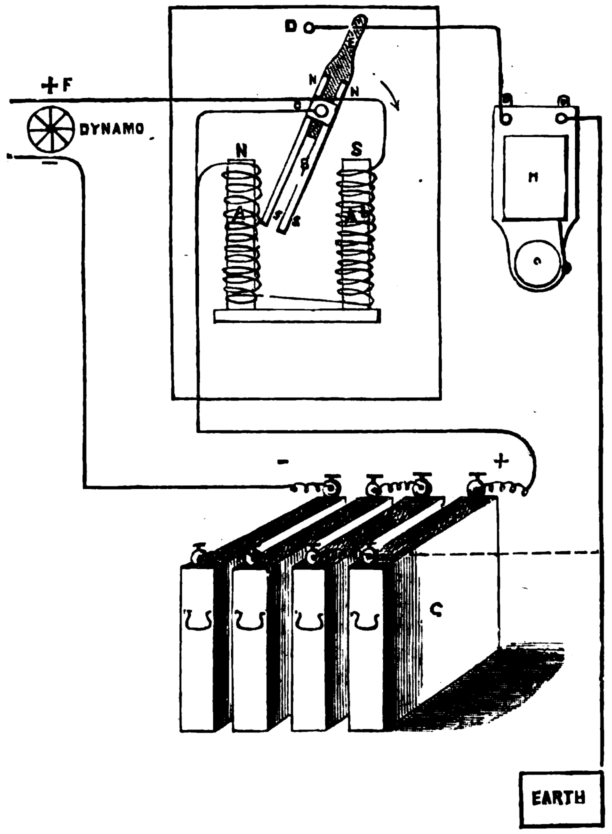
A Student.

8, Claremont-place, Gateshead, Nov. 6, 1882.

CHARGING SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to the above operation, and to the arrangement adopted by Mr. Crawley, published in your last edition of *The Electrician*, for giving warning of reversal of current in charging accumulators, I beg to offer enclosed sketch, which I have devised for doing the same, this arrangement being entirely self acting, and requiring no adjustment, the simplicity of which will be seen in sketch. A A is electro-magnet in main circuit; B, permanent steel magnet acting as a switch



current reverser or cut out; C, pin on which magnets B oscillate; D, pin which arm E comes into contact with on reversion of current or stopping of engine; F, dynamo single circuit or shunt; G, accumulators; H, electric bell placed convenient to those in charge of apparatus. To pin C is connected wire from + pole of accumulators from contact pin D to electric bell, out of bell to earth on to negative pole of first accumulators, as shown by dotted lines. We know the positive current entering electro-magnet at A + would cause that pole to become south, the steel magnet forming switch with it; S poles downward would be repelled, the opposite pole of electro-magnet A would attract it. This position would remain constant so long as the current proceeded in the same direction. Should the E.M.F. of accumulators exceed that of dynamo, which, through many causes, often happens with single-circuit machines, or should the engine slacken or stop, the current would flow in the reverse direction from accumulators to machine. Immediately this reversion takes place the current enters electro-magnet in the opposite direction, in doing which it causes poles of same to reverse permanent steel magnet B, the poles of which remain constant, is, of course, repelled

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and attracted by opposite pole of electro-magnet. In doing this the arm E is brought into contact with pin D, and shunts a portion of the positive current through bell to earth, or otherwise. The above arrangement could be modified so as to do useful work in connection with alarms, &c., in charging secondary batteries.—Yours, &c., H. A. KENT.

154, Culford-road, N., Nov. 6, 1882.

TRICYCLES DRIVEN BY ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent "Chancery-lane" may well ask, "What is the Use of our Electric Tricycle?" if in this fast age one is to be compelled to travel at the ignominious rate of four miles per hour, and have an *avant courier* with a red flag to announce our coming to Hodge and his cart-horses.

Of course, we all know that the Act of Parliament was aimed at traction engines, steam rollers, and such like noisy but useful monstrosities, and not at the useful and natty tricycle or any other form of velocipede driven by electricity. The Court of Queen's Bench, however, in their wisdom have decided that tricycles driven by other than animal power do come within the meaning of the Act, and that any person using one except in compliance with the provisions thereof is liable to a penalty not exceeding £10.

Now, I take a great interest in electric tricycles, and I quite agree with Mr. Reckenzaun that the subject of locomotion by electric energy is of immense interest to all classes, and, being so impressed, I, in my blissful ignorance of the law, set to work to build one, when all at once, to my horror and consternation (and I have no doubt to that of many other similar workers in the same cause), came the decision in Parkyns *v.* Priest. My friends consoled me with the belief that the case would be appealed, and the decision upset. For confirmation of this view I had an interview with my lawyer, but all I got from him was a shake of the head. I frantically endeavoured to impress upon his legal mind the difference between a traction engine and a tricycle, but he refused to be convinced, and pointed grimly to the words of the Act, "other than animal power." These words seemed to haunt me like Banquo's ghost, and I began to consider their insertion in the Act as a kind of personal injury, until one day a happy thought struck me which ultimately developed into a practical idea. This I embodied in a specification, and submitted it to my grim lawyer, who returned it with a grin and an expression of opinion that an electric tricycle built upon my improved plan would not be an infringement of the Act, but, with the natural caution of his class, advised a conference with counsel. A counsel well known and respected by most inventors was thereupon consulted, and my lawyer's opinion was fully confirmed. A specification has, in consequence, been duly filed, and in due course will be made public.

I have only mentioned the above trifling facts for the benefit of our legal friend, "Chancery-lane," who doubtless has been having a good chuckle over the electricians and their tricycles; but, for the information of others, I may state that the principle of the invention is the use of electricity as a simple auxiliary, thus reducing the "animal power" required for propulsion to a minimum, but so arranging the machine that without such "animal power" (however small) being exerted continuously the tricycle remains motionless.

I hope to have a machine, made on the above principle, completed in time for the approaching Exhibition. I shall then have great pleasure in sending you full particulars, with diagram, weight, &c., if you consider the matter of sufficient interest to your readers.—Yours, &c.,

JNO. MACDONALD, C.E.

5, Southampton-buildings, Holborn, W.C.

AN ELECTRIC TRICYCLE.

Professors Ayrton and Perry write us that the electromotor used for driving the tricycle has been patented, and it will shortly be open to the public to read a full description of the motor.

CABLE WORK IN EGYPT.

Those interested in cable work will be glad to see by the following letters that the work of the staff of the Eastern Telegraph Company has been fully appreciated by the Government and the naval officer in command of the late operations:—

Admiralty, 3rd Oct., 1882.

SIR: I am commanded by my Lords Commissioners of the Admiralty to request that you will lay before the Board of Directors of the Eastern Telegraph Company the enclosed copy of a letter, dated at Suez on the 10th ult., from Rear-Admiral Sir William Hewett, directing attention to the assistance he has received from Mr. Tuck, the Superintendent of the Company at Suez, and from his deputy, Mr. James Hammond.

My Lords desire me to request that the Board of Directors will convey their thanks to Mr. Tuck for the services he has so efficiently rendered in connection with Her Majesty's naval forces.—Yours, &c., (Signed) G. TRYON.

The Secretary, Eastern Telegraph Company.

"Euryalus," at Sea, 10th Sept., 1882.

SIR: I desire to bring to the notice of the Lords Commissioners of the Admiralty the great assistance that has been rendered me by the Superintendent of the Eastern Telegraph Company at Suez since the place was occupied by British forces on the 2nd August last.

The recent arrival of a staff of Royal Engineers to establish a military wire between Suez and the front affords me a suitable opportunity of expressing my appreciation of Mr. Tuck's able management of his company's Government business, and the courteous and ready way in which my calls upon that gentleman and upon Mr. James Hammond, who has been in charge here when Mr. Tuck has been temporarily called from his post, have been at all times responded to, demands an official acknowledgment from me, which it gives me very great pleasure to accord.—I have, &c.,

(Signed) W. HEWETT,
Rear-Admiral and
Commander-in-Chief, East Indies.

"Euryalus," at Suez, 11th Oct., 1882.

SIR: Being about to return to India I particularly desire to bring before your notice the courtesy and valuable assistance I have received from your superintendent at Suez.

2. I have never hesitated to call upon Mr. Tuck for any services the Government has required during the recent operations in Egypt, and on all occasions he has responded with a heartiness which deserves my highest approval.

3. Mr. Hammond, too, has been extremely obliging and useful, and the way the Government telegraphic business has been conducted here reflects the greatest credit on all concerned.

4. I have also communicated my opinion of Mr. Tuck and Mr. Hammond to the Lords Commissioners of the Admiralty.—I have, &c., (Signed) W. HEWETT,
Rear-Admiral and
Commander-in-Chief, East Indies.

CHRONOGRAPH FOR ENGINEERING PURPOSES, WITH THE HIPP ESCAPEMENT.*

The engraving given herewith shows the general construction of an improved chronograph for engineering and other purposes.

The instrument has been successfully applied to some of the different types of large pumping engines, such as direct-acting fly-wheel engines, geared pumping engines, and the "Davey engines;" it has also been used to determine the

* W. R. Eckart in the *Scientific American*.

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motion and relative motion of pump rods and pumps some 2,500ft. below the surface engine driving same, and at intermediate points. The results are exceedingly interesting and instructive, and as numerous indicator cards were taken from the engines and pumps simultaneously with the motion diagrams, nearly all conditions of motion and power, during the time under consideration, were definitely determined, and may hereafter form the subject of other papers.

Some very important results of the elasticity of long pump rods are clearly set forth; in one case, a rod at a point 1,800ft. below the surface showed a positive pause, while the engine driving it was nearly at its point of maximum motion, and pumps attached to the rods may, and do have, strokes in excess of or deficient to the stroke of engines driving same, and to an important extent. Hence it can be definitely stated that any consideration of motion of pumps, or discharge capacity of same, driven by a long line of pump rods based upon the motion or stroke of a surface engine alone, will in no way be even approximate, unless the elasticity and effects of counterbalancing by balance bobs on that elasticity are also considered.

The effects of different degrees of compression upon the engines and motion of the pump rods in passing the centers have been considered, and the diagrams clearly show the importance of considering it in connection with the strength of the rods and balance bobs.

The latest use of the instrument in conjunction with an engine test has been to determine, if possible, the rate of condensation of steam, per second, in the steam cylinders of a pumping engine, where the change of motion, due to each fractional part of the stroke, was determined. Also, a ten hour experiment trial to show the economy of compression, as compared with a ten-hour trial of the same engine on the succeeding day where no compression was used (otherwise all conditions being similar), has been made, when changes of velocity of piston were determined by the chronograph.

This chronograph has been put to a variety of uses, among which are recording seconds as well as the velocity curve of engines, and timing horse races, &c. It has also been used in the Navy Ordnance Department for determining the speed of projectiles.

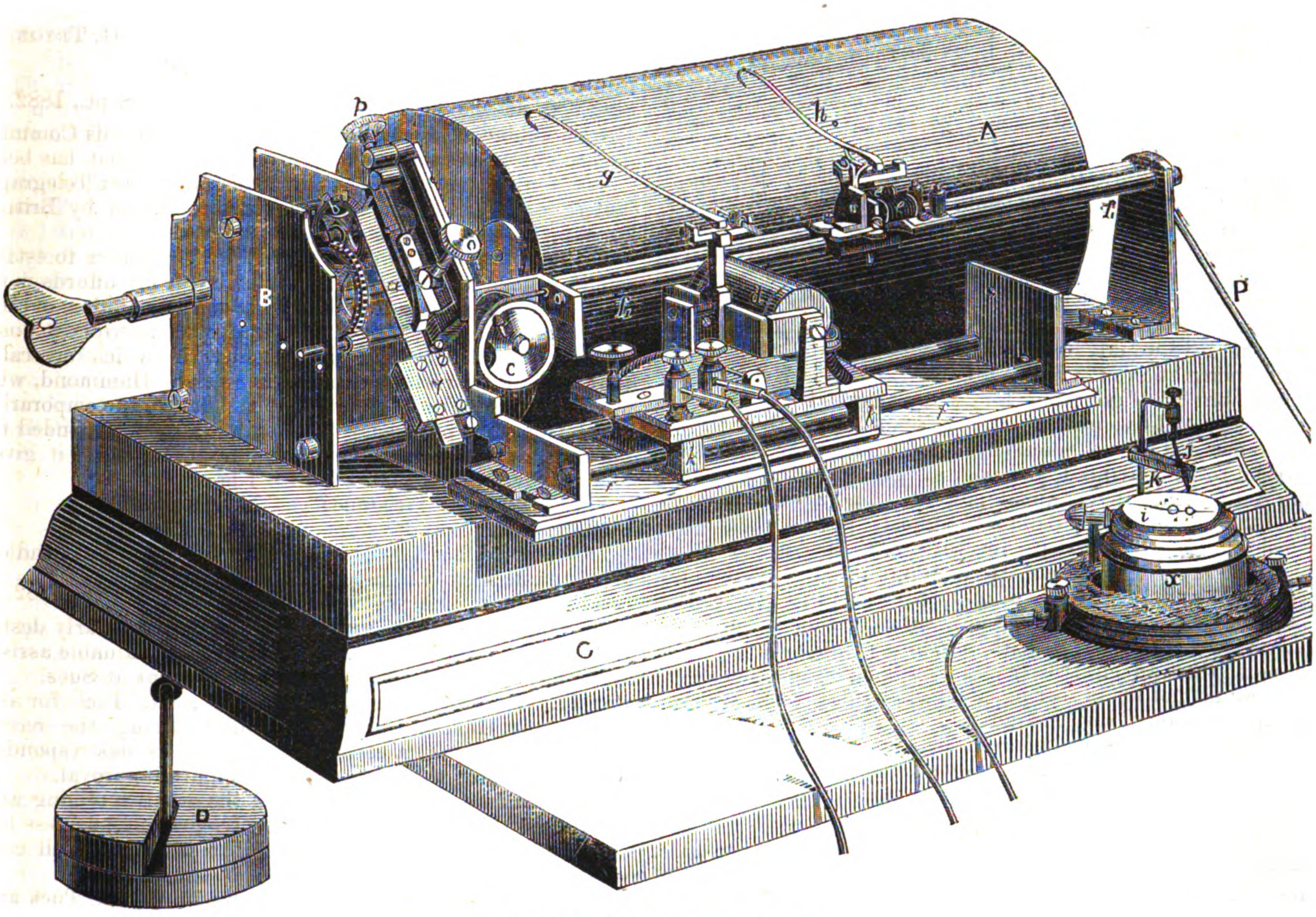
In the following paragraphs we give the references by letters to the engravings of the instrument:—

C, cast iron base plate covered with sheet brass, upon which the mechanism is secured.

B, metal frame containing gearing for driving drum A, and escapement wheel *b*; motion communicated by means of adjustable weights D.

A, light brass drum accurately balanced, revolving on friction rollers at both ends.

ff, parallel guide bars, upon which the tracing point h_o and its carriage travel back and forth, receiving motion, in one direction, from the engine or other moving parts, through the cord P, passing between the bars *f*, and attached to the tracing carriage; the return motion is derived from a coiled spring in the spring drum C.



Chronograph for Engineering Purposes.

e e, small electro-magnets on tracing carriage, for raising the tracing point h_o off the paper and replacing it at any desired point to be especially observed.

d, electro-magnet on separate carriage *k k*, adjustable on parallel bars *f*, operating the steel tracing point *g*, attached to the armature of *d*, for the purpose of recording seconds on the margin of the paper or at other parts of same as required.

i, chronoscope or watch supported on frame X, the second hand of which swings the light platinum wire J, breaking contact with the insulated wire *k*, thereby breaking circuit with *d*, and recording seconds through the tracing point *g* on the paper.

q represents the adjusting screw for the wire J.

a, steel spring of escapement. This spring is securely clamped in Y, its flexibility being controlled to a certain extent by means of the thumbscrews *o* and *p*.

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THE CHEMISTRY OF THE PLANTÉ AND FAURE ACCUMULATORS.

Dr. Gladstone made a communication, at the late meeting of the British Association, on this subject, in which he referred to experiments the results of which had not then been published. These experiments were a continuation of those described in various papers to *Nature*, more particularly those described in Paper No. III. We now give this paper, together with Paper No. IV., which appeared in *Nature* of October 19.

Part III.—The Discharge of the Cell.

The two plates of a Planté or Faure battery consist essentially of lead peroxide as the negative element, and metallic lead in a spongy condition as the positive. These are brought into communication with one another through the lead plates which support them, together with the connecting wire.

The lead peroxide reacts both with the lead plate that supports it, and with the lead on the opposite plate. At first sight, it might be expected that the reaction between it and the supporting plate would be the greater, as the space between them is so small, and the resistance of the intervening liquid in consequence almost inappreciable. The action is, indeed, probably greater at the first moment, but, as explained in our first chapter, sulphate of lead is immediately produced, and that which lies at or near the points of junction forms, no doubt, a serious obstacle to further local action, and admits of the lead on the opposite plate coming more fully into play.

If we consider *à priori* what is likely to be the reaction between lead peroxide and lead, with water as the connecting fluid, we should expect:—

$$PbO_2 \mid H_2O \mid H_2O \mid Pb = PbO \mid H_2O \mid PbH_2O_2.$$

On experiment this is found to be actually the case, yellow oxide appearing on the negative plate, and white hydrate on the positive.

If, however, the reaction takes place in presence of dilute sulphuric acid, the result will inevitably be sulphate on both sides, for even if oxide be first formed, it will be attacked by that acid. Of course this production of lead sulphate on each side might be expected gradually to produce a perfect electrical equilibrium. This, in fact, does take place under certain circumstances, but not under others. The reaction on the negative plate is always of this character, as far as our analyses have shown. We have invariably found the deposit to consist of sulphate of lead mixed with unaltered peroxide. If, however, the cell be allowed to discharge itself rapidly, the lead on the positive plate is converted, not only into the sulphate, but, very partially, into lead peroxide. This is sometimes evident to the eye from the puce colour of the superficial layer, and we found also that this was confirmed by several chemical tests.

It is difficult to conceive how the reduction of the peroxide of lead on the one plate to oxide or sulphate should be attended by a direct oxidation of lead on the other plate up to peroxide itself, as that would involve a reversal of the electromotive force. It is more easy to imagine that the peroxide results from the oxidation of sulphate of lead already formed, through the agency of electrolytic oxygen.

When this peroxide is formed on the positive plate it is not difficult to foresee what must happen. A state of electrical equilibrium will be approached before the peroxide of lead on the negative plate is exhausted. But the two sides are in very different positions with regard to local action. On the negative plate, the peroxide being mixed with a great deal of lead sulphate, it will suffer decomposition only very slowly through the agency of the supporting plate, but the lead peroxide on the positive plate, being mixed not only with lead sulphate, but with spongy metallic lead, will be itself speedily reduced to sulphate. Hence, on breaking the circuit, when local action alone can take place, the peroxide formed on the positive plate during the discharges will be destroyed much more easily than the original peroxide on the other plate. The difference of potential between the plates will be restored, and on connection the cell will be again found in an active condition.

Now, it has been frequently observed that partially discharged accumulators do give an increased current after repose, that is, after the circuit has been broken and re-established. It remained for us to ascertain whether the chemical change above described coincided in any way with the physical phenomena. For this purpose we prepared plates according to the method of Faure, and examined carefully the changes of electromotive force and strength of current, which took place during their discharge under known resistances, and the chemical changes that took place under the same circumstances.

We found that the initial electromotive force of freshly prepared cells was 2·25, 2·25, 2·21, and 2·31, volts, averaging 2·25, but that after standing for thirty minutes or so, or when allowed to discharge for a few minutes, it was reduced to about 2·0 volts. We take this to represent the normal electromotive force of the arrangement of lead, lead peroxide, and dilute sulphuric acid, and believe that the higher figure obtained at the first moment is due to the hydrogen and oxygen occluded on the respective plates, and which either diffuse out or are speedily destroyed.

We found, however, that in the discharge the electromotive force diminished under certain conditions. Thus, in an experiment in which the external resistance was 1 ohm, and the internal 0·58 ohm, the E.M.F. sank in forty-five minutes from 2·25 to 1·92, but after being disconnected for thirty minutes, it was found to have risen to 1·96, and after eighteen hours' repose it had actually risen to 1·98 volts. These observations were made many times in succession during the course of the experiment, which lasted six days.

With twenty times the external resistance, the diminution of electromotive force was much slower; but after discharging three days, the fall was more pronounced, and the rise on repose very apparent.

With 100 ohms resistance the electromotive force varied very little for three days.

It is more difficult to obtain satisfactory chemical evidence of a quantitative character. It is clear that as chemical examination means the destruction of the substances, the same plate cannot be analysed in two consecutive stages. Nor can two plates be easily compared with one another, although they have been formed under the same circumstances. Even the same positive plate, during or after discharge, presents to the eye very different appearances in different parts. To a certain extent we obviated this difficulty by cutting the plate in two, longitudinally, analysing the one half at once, and allowing the other to repose for a given time before examining it for peroxide of lead.

As to the estimation of peroxide in the presence of metallic lead, we finally adopted as the best method that of reducing it by means of oxalic acid, although we were not certain that the whole amount is obtained in this way, even though the solution be kept hot for a considerable time.

By this method many chemical examinations were made of the positive plate. The results are as follow:—First of all, when the external resistance did not exceed 20 ohms the peroxide of lead was generally visible in patches, and its presence was demonstrated and approximately measured by various chemical tests. On repose, the quantity of this peroxide visibly diminished, and in the majority of instances the chemical analyses also showed a smaller amount. In all cases sulphate of lead makes its appearance early in the action, and gradually increases in quantity, becoming finally the only product of the discharge.

The deposit on the negative plate shows the presence of nothing but sulphate of lead in addition to the unchanged peroxide. At the conclusion of the action we have always found more or less of this substance unaltered. Thus, as one instance, after a discharge lasting five days, and approximately complete, we found that only 68 per cent. of the deposit was lead sulphate.

We conclude, therefore, that the chemical action of the

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discharge is essentially what is expressed by the following theoretical formula:—

$$PbO_2 \mid H_2SO_4 \mid H_2SO_4 \mid Pb = PbO \mid H_2O \mid H_2SO_4 \mid PbSO_4,$$

which becomes

$$PbSO_4 \mid H_2O \mid H_2O \mid PbSO_4.$$

This reaction is, however, sometimes complicated by the formation of a small amount of peroxide of lead on the positive plate. We believe this to be due to the oxidation of sulphate, an action which was explained in our last chapter.

Another conclusion has reference to the resuscitation of power observed on repose. This is not due to any purely physical action, but is a necessary consequence of the formation of PbO_2 on the positive plate. As sooner or later the result of the action becomes solely $PbSO_4$, this temporary formation of peroxide does not seriously affect the quantity of electrical force that may be regained from the accumulator, but it does affect the evenness of its flow. The flow is more regular if the discharge be made slowly, but in that case the loss on the negative plate from local action will probably be greater.

As to the practical conclusions we may note:—1. Although, as stated in the first chapter, the most economical arrangement for the initial charging of the cell is to "make the red lead to be hydrogenated much smaller in amount than that to be oxidated," yet, as foreshadowed in the same chapter, this arrangement is not desirable for the discharge of the cell. Nor is it for its subsequent charging, since, as will have been seen, the substances to be acted upon are now very different. On the negative plate there will be the sulphate of lead produced by the discharge, plus sulphate of lead produced by local action, together with more or less unaltered peroxide. On the positive plate there will be the sulphate of lead produced by the discharge, together with excess of lead, if any. Unless, therefore, the peroxide of lead unacted upon is allowed to be very considerable, the quantity of lead compound on the two sides ought to approach equality. 2. Care should be taken that sulphuric acid is in sufficient excess to allow of there still remaining some of its solution after all the available lead has been converted into sulphate. If it is removed and only water is present, an oxide or hydrate will be produced, with probably some serious consequences to the cell.

Part. IV.—The Function of Sulphate of Lead.

In our previous communications on the chemistry of the lead and peroxide batteries we have frequently remarked on the formation of lead sulphate and its importance in the history of a cell.

In Part I. we showed that the local action that takes place, at first energetically, between the metallic lead and the peroxide is gradually diminished by the formation of sulphate of lead.

In Part II. we stated that in the original formation of a Faure cell sulphate of lead is oxidated on the one plate and reduced on the other. We also described an experiment in which two platinum plates were covered with lead-sulphate, immersed in dilute sulphuric acid, and placed in the circuit of a galvanic current, the result being that "the white sulphate was decomposed to a large extent on each plate, the positive being covered with deep chocolate-coloured peroxide, the negative with grey spongy lead."

In Part III. we showed that on the discharge of a cell lead sulphate is the ultimate product on both plates.

It might naturally be inferred from our previous statements that in the recharging of a cell this lead sulphate would be oxidated on the one plate and reduced on the other, as in the original formation. This matter, however, has given rise to some controversy. All subsequent experimenters admit the *oxidation* of the lead-sulphate, but Dr. Oliver Lodge could not obtain any reduction of it, when pure sulphate was employed. Sir William Thomson, also, when experimenting with two platinum plates and layers of sulphate, obtained only a doubtful indication of reduced metal. The question as to whether the sulphate is reduced or not on recharging a Faure cell is one of vital importance; for if the sulphate formed at each discharge accumulates on the positive plate it would clog up the space, and, what is perhaps worse, a fresh surface of the lead would have to be oxidated (or, rather, converted into sulphate) at each discharge. Thus the positive plate will be continually corroded, and its life will be limited.

We have already replied to Dr. Lodge in *Nature*, but we thought it desirable to repeat the experiment with the platinum plates, especially with a view to determine whether the reduction was effected slowly or with any rapidity. We fastened 20 grms. of the white sulphate upon a negative plate by binding it round tightly with parchment-paper, placed it vertically in the sulphuric acid, and passed a continuous current of somewhat under an ampere. The hydrogen was at no time wholly absorbed—indeed, the greater part of it certainly escaped—but after the lapse of twenty-four hours, small patches of grey metallic lead became distinctly visible through the wet parchment-paper, and these gradually spread in an irregular manner. At the end of ten days it was found that the whole of the sulphate, except a few small patches on the surface, was reduced to a grey spongy mass. Although there could be no reasonable doubt that this was metallic lead, a portion of it was tested chemically, and proved to be such.

It thus appears that the *reduction* of the pure sulphate of lead is an absolute fact, although it does not take place so easily as the oxidation.

In an actual cell the sulphate of lead is, of course, mixed with other bodies. Thus, in the formation of a Faure battery, the minium is converted by the sulphuric acid more or less completely into peroxide of lead and sulphate. We have already described an experiment in which 4,489 c.c. of hydrogen were absorbed on a plate, the materials of which were capable of absorbing only 4,574 c.c., if the whole sulphate as well as the peroxide was reduced. In our notebook we have the particulars of four other experiments made in each case with the same, or nearly the same, amount of material, in which 4,199, 4,575, 4,216, and 4,387 c.c. respectively were absorbed, although perhaps in not one of these cases was the experiment continued until the action was absolutely complete. As, however, it may be objected that the amount of sulphate produced upon these plates was an unknown quantity, we have in a recent experiment treated the minium in the first instance with a considerable amount of sulphuric acid. This gave us a mixture which, on analysis, was found to contain 18·5 per cent. of sulphate of lead. This mixture, when submitted to the reducing action of a current yielded a mass of spongy lead that contained only a mere trace of sulphate.

As it seemed desirable fully to establish the fact that the sulphate of lead formed on the discharge of a cell is reduced in the subsequent charging, we took the quondam lead plate of a fully discharged cell, determined the proportion of sulphate to unaltered spongy lead, and submitted it to the reducing action of a current. The amount of sulphate on the plate before passing the current was found to be 51 per cent., but, after the passage of a current of about an ampere for 60 hours, not a trace of it remained.

Hence it may be concluded that, during the alternate discharging and re-charging of a Planté or Faure cell, sulphate of lead is alternately formed and reduced on the lead plate, and that the plate itself is not seriously corroded. It would, however, appear desirable not to allow the whole of the spongy lead to be reduced to sulphate during the discharge, for two reasons, viz.: (1) because the supporting plate stands a chance of being itself acted on if there is not a sufficient excess of spongy metal; and (2) because the presence of this excess tends to facilitate the reduction of the sulphate.

We have already shown that sulphate of lead is produced by the local action that takes place between the peroxide and its supporting lead plate during repose. The same local action also takes place during the charging of the plate, as was pointed out in our second communication, and this sulphate is, in its turn, attacked by the electrolytic oxygen. In this way the absorption of oxygen in forming the negative plate ought never to come to an end. In order to see whether this was the case, we allowed an experiment to continue for 115 hours, although the main action was over in about forty

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hours. For the last two days of the experiment, the amount of oxygen absorbed was pretty constant, being about 9 c.c. per hour, which is equivalent to 0·24 grms. of sulphate of lead formed and oxidated. The whole charge on the plate was 40 grms. of peroxide. This local action also takes place during the discharge, as is evidenced by the sulphate of lead formed on the negative plate always exceeding in amount that formed on the positive plate.

Through this local action taking place during the formation of the cell, during repose, and during the discharge, the lead plate which supports the peroxide must be continually corroded more and more; and it is probably due to the insolubility of the sulphate formed that the destruction of this kind of secondary battery is so materially retarded in practice.

J. H. Gladstone.
Alfred Tribe.

FAURE ELECTRIC ACCUMULATOR COMPANY (LIMITED).

An extraordinary general meeting of this Company was held at the City Terminus Hotel on the 6th inst., under the presidency of Sir A. J. Otway, M.P.

The Secretary (Mr. Herbert Canning) having read the notice convening the meeting,

The Chairman, in opening the proceedings, observed that commercial matters differed from political or diplomatic matters in that there was really very rarely reason for any mystery or secrecy concerning them; and his system had always been that those who were partners with oneself should be at once taken into one's confidence. If that were a sound principle he need offer them no excuse for asking them to meet and consult with the directors, and give them the benefit of their opinion when a proposal was made to alter in any way the lines of policy on those which the shareholders, having been previously consulted, had decided to act. That, in short, was the cause of his asking them to meet on that occasion. They were aware that last June he, as the mouthpiece of the Board, asked the shareholders to consent to certain lines of policy on which the affairs of the Company were to be carried on. The directors had acted in pursuance of the decision unanimously come to at the meeting, and had continued, as far as they could, to further the interests of this Company according to the ideas which they advocated at that meeting. They had made considerable progress while so doing. He should be happy later to answer any question concerning the administration of the Company, but at present there was a matter of far greater importance before them. A proposal would be submitted to them of a very important character. The shareholders would hear what was to be said in its support, and they would have to decide on it. It might be that the shareholders would desire to have the opinion of the directors concerning the proposal, and in that case it would be his duty to state his opinion frankly to them. He would, however, rather that they should first hear the proposal stated by the persons most responsible for it. He should, therefore, now call on them to make known this proposal, at the same time remarking that the Company was under a somewhat unusual—indeed, he should say a very special circumstance, an influence that was dominating and would dominate any Board or company situated like this Company, namely, that three-fourths of the entire property were in the hands of a very few gentlemen, of whom the gentleman who made this proposition, M. Philippart, was the exponent. It was needless to say that such a fact must be taken into account in everything they did; and when a gentlemen holding three-fourths of the property propounded a policy, and said it was greatly to his advantage, and therefore greatly to the advantage of the Company, it would be very unfair, and very improper not to allow a hearing to any one so situated. Of course, outside such an interest, the directors had the duty of defending, in the interests of the whole body of shareholders, any interest which they might consider unjustly attacked. He pronounced no opinion as to the policy to be indicated—he only wished them to understand that the directors recognised their duty fully to all the shareholders. Although he knew that M. Philippart could convey his ideas in English with very great clearness, that gentleman thought it better that his statement, written out in French, should be read to the meeting in English. He then called upon M. Philippart to request some gentleman to read the statement.

Mr. Campbell (the solicitor) read the statement as follows:—

"Gentlemen: Before explaining my programme to you, I would wish to cursorily refer to the past. When our Company was formed I submitted this same programme to your directors, stating to them that, in the opinion of the vendors, it was the best, indeed the only one which would insure prompt and large dividends. For reasons which, if they deem fit, my colleagues will certainly be better able to explain to you than myself, this programme was not adopted by your Board, and in consequence the differences arose between them and the vendors of which you were made aware at our first statutory meeting, and which brought about an arrangement between myself and another company who were the proprietors of the only accumulator which could possibly in any way compete with the Faure accumulator. Consequent upon these arrangements I, of my own accord, entered into an agreement, which was afterwards approved by your directors and adopted by you at our meeting held on the 29th of June last. You will recollect, gentlemen, that one of the principal clauses of that agreement accorded to our Company the option of purchasing the Faure, Sellon, and Volckmar patents, for France and the rest of the European continent. When the agreement just referred to was confirmed by you, your directors invited me to take a seat at the Board. From that moment, gentlemen, I persistently endeavoured to convince my colleagues that it was desirable to abandon the policy they had adopted for that which I had from the outset proposed to them, and which could still be successfully carried out. I did not succeed, gentlemen, without great difficulty, and in order to attain success my friends and I had recourse to an irresistible argument. We became proprietors of three-fourths of the ordinary shares of your Company, we who already held all the deferred shares. In the face of such a proof of confidence in my projects and my policy, as that accorded by my friends, only two courses remained open to gentlemen such as constitute your Board: one was to resign the direction of your Company to my friends and myself, the other to act thoroughly in unison with us. The first alternative would naturally have been the readiest for my colleagues to have adopted, but it would have been most deeply and sincerely regretted by my friends and by myself, and we would have made any sacrifice rather than lose the co-operation of the majority of your Board. I, therefore, unceasingly endeavoured to convince them that the policy I foreshadowed was the policy in every way most advantageous to you, gentlemen, and hence to-day's meeting, my colleagues, in their loyalty to you, not wishing to change their policy without your full and entire approbation. Let me add, gentlemen, that my friends and I myself hope and wish for this approval in the full as much as do my colleagues. We come from a little country, Belgium, whose motto says that 'Unity is strength.' We wish for unison and mutual confidence. With this intention the Société la Force et la Lumière has made you an offer which has already been accepted by many of you, and which would, in all probability, have been accepted by the greater number, if not, indeed, by all of you, had it been thoroughly understood. We have been asked for explanations which could not be given before to-day's meeting, but which we now offer; indeed, in order that you may thoroughly understand them it is only necessary to set forth our programme. This programme, gentlemen, is clear and simple. Our company must, henceforward, cease to be an industrial company manufacturing accumulators for sale or for its own use, and must become a company for the formation and constitution of affiliated companies; to which companies we shall sell licenses for cash, and for cash and fully paid shares, and we shall also sell licenses to private individuals and already existing companies. Thus we shall readily and quickly make large profits, and the local and affiliated companies will pursue the policy my colleagues had thought of adopting for our company. By this policy profits of 10 or 15 per cent. may be made on the capital invested, profits which may and should satisfy local companies, but which will not suffice for us, gentlemen, we who look upon ourselves as the sole possessors of one of the greatest inventions of the age. Let me make a supposition and cite an example in justification of my policy. Supposing that some forty years ago we had been possessed of the only practical means of storing gas in a gasometer, and that, having in hand valid patents for such an invention for the whole world, we had contented ourselves with making gasometers of different dimensions in order to sell them to any purchaser; or that we had only employed our capital in constructing works to light a suburb of London, instead of establishing local companies which would have purchased from us our indispensable patents at any price—why, we should have been considered insane! Well, gentlemen, that which we possess stands in the same relation to electricity as does the gasometer to gas, that is to say, that it is an indispensable element, despite what those may say who have no accumulator, with the difference only that the future of electricity is ten times greater than that which can ever be attained by gas. Gentlemen, the only practical and economical accumulator is the Faure Sellon Volckmar accumulator; everything leads us to believe and suppose that it will not be superseded, and we are the owners of the Faure Sellon Volckmar accumulator. For some months past one of the most eminent men, and one of the greatest inventors of our time, Sir Henry Bessemer, whose fortune proves the value of a great invention, has, looking ahead, stated publicly and repeatedly that by means of electricity power and light will ere long be generated at the pit's mouth, to be thence generally and economically transmitted by wires, just as thought and sound are now communicated by the telegraph and the telephone. Well, gentlemen, this great economic revolution which will, I do not hesitate to affirm, soon become an accomplished fact, can only be so accomplished by our co-operation, and, being in such a position, ought we to be satisfied with being simple manufacturers of electrical reservoirs? No, gentlemen, we will, with your approval, do greater things. But, gentlemen, if large profits are to be realised by electricity in England, what may not these profits amount to on the Continent, where light and motive power cost 50 per cent., 100 per cent., and often even 200 per cent. more than in England. Therefore, gentlemen, we should purchase, resell, and farm the French and Continental patents, and this is what we will do. But in order to do this we must have funds, and consequently it will be necessary to call up as quickly as possible the £8 per share which still remain uncalled up on the 40,000 ordinary shares in our Company. These calls should be made forthwith; but, in accordance with the terms of our prospectus, you need only pay £1 per share per month. The Board is, however, authorised to accept payment of calls in advance, and it is in order to further and facilitate such an arrangement that the Société la Force et la Lumière offers to each and all of you to give you one £10 share fully paid in the Faure Accumulator Company (Limited) in exchange for every two shares, £2 paid, which you hold in the Faure Accumulator Company (Limited). As we shall ask for a quotation for the fully paid shares in our Company at the beginning of the year, it is to the evident interest of all to make payment of calls in advance. Those who may not feel disposed to make these payments in advance will probably accept the proposal made to them by the Société la Force et la Lumière, which not only relieves them of all future calls, but gives them in addition a profit of £3 on every share they possess in the Faure Accumulator Company. The offer made by the Société la Force et la Lumière will remain in force until 12 o'clock on Friday next, the 10th inst. If our programme be adopted and our policy be followed, the Société la Force et la Lumière undertakes to pay up in full, before the 1st January next, all shares, including those which you respectively transfer to us, so that on and after that date no ulterior responsibility can attach to the shareholders in the Faure Company. These, gentlemen, are the explanations I have to offer to you, explanations which I trust you may consider satisfactory."

The Chairman then invited discussion on the policy enunciated in the statement which had been read.

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A SHAREHOLDER said that the feeling in his mind and in the minds of most of those present was that they would like to understand something as to the object with which the offer was made. He thought further explanation was required in the face of the offer of a premium of £3 a share.

A SHAREHOLDER, who said he owned 155 shares, stated that he knew no more about the proposal than those present, but it appeared to him a very good thing, and he should be disposed to accept the offer. If, however, there was anything to be said against the proposal he should like to hear it.

M. PHILIPPART having made some observations to the chairman in French,

The CHAIRMAN stated that he spoke as the mouthpiece of M. Philippart, who, in reply to the remarks just made, said that shareholders had two courses open to them. Those who thought the matter very valuable should retain their shares, with the £8 liability on them, as if the shares went to a very large premium they would have a greater reward for their confidence, while those who thought less well of the business and of the prospects, and who wished still to retain an interest in the Faure Company, should, it seemed to M. Philippart, accept the offer which the Société la Force et la Lumière made, because they would in that way be free of all liability, and still retain a very considerable interest in the Faure business. The cause of the offer of the Société la Force et la Lumière being so liberal was owing, M. Philippart stated, to the confidence of that body in the goodness of the concern, and their belief that they would get still more advantage than the £3 a share they offered to the shareholders.

A SHAREHOLDER observed that he did not feel inclined to transfer his shares until they knew all about the future policy submitted to them. If it was worth the while of the Société la Force et la Lumière to pay up the liability of £8 a share on his shares it was worth the while of the shareholders to do so.

The CHAIRMAN: Then you must have the same confidence as the Société la Force et la Lumière.

In reply to a SHAREHOLDER, who asked who were to be the directors of the new company,

The CHAIRMAN stated that there was to be no new company—there was no other proposal before them than the question of making an alteration in the line of policy which they had hitherto followed, which was that they should be an industrial company, to make accumulators, and he must here say that he regretted the non-establishment of a construction company to make experiments as to the accumulators. The proposal before them, however, was as to whether they should depart from the policy they had approved and hitherto followed. To speak frankly, he believed the proposal had come about simply in this way. Several shareholders and persons had pointed out to him the enormous sums of money which had been made by the Brush Company, and the large sums made by the *quasi* partners of this company, the Storage Company, while the Faure Company, it was said, was making comparatively no money. Then it was asked how this state of things existed, and the reply was because the Faure Company was an enterprise in the regular way, endeavouring to perfect an instrument which no doubt in course of time must have given them considerable profit. It had not done so, however, yet, and therefore enterprising men had said, Let us act on different lines (as had been indicated by M. Philippart), let us sell these licenses to other companies, and especially in France, where the conditions are more favourable than they are in England, the price of gas being so much larger. These gentlemen had seen a field for their enterprise much more likely to be profitable than the course the Company were now pursuing. To do this, however, the French patents must be purchased, and up to a certain date they could become possessors of the patents; and therefore these gentlemen said, Pay your calls, get more capital, and work in this larger field in the way we have indicated. In saying this he (the Chairman) told them all that he knew about the proposal. As the meeting, however, seemed to be looking for guidance, he would tell them what he meant to do. If the shareholders approved the change of policy which had been indicated he meant to effect the exchange. In that way he should get relieved of all liability by a sacrifice which he was ready to make. It would be very disagreeable for him, as it would be to many others, to pay up the £8 a share, but it would be more disagreeable to him to part with his interest in the Faure invention, which he believed to be the greatest one of modern times, with an enormous future. What surprised him was the liberality of the offer; but what had disappointed him was that the time given for arriving at a decision was only up to the day of the meeting. This he pointed out to M. Philippart would be rather hard on the shareholders, and he expressed his opinion that the offer should remain open till the next day or Wednesday. M. Philippart met this objection in a very liberal spirit, and even extended the time to Friday. He knew no more about the matter. Their pecuniary advantage would of course depend in future, if the proposal were accepted, on the success of those who would carry out the enterprise in France. There could be no doubt whatever that, if these licenses were sold, and companies were constituted in France, the profits would be very large. If they failed they could judge as well as he as to what their position would be. What was clear was that they would be relieved of all liability from the 1st of January next if they accepted the offer.

A SHAREHOLDER inquired if the gentlemen from whom the proposal came were able to meet the call.

The CHAIRMAN replied that they need not part with their shares until they got the proper exchange. As a man of business he should not part with the article he possessed until the article which was to be given in exchange for it was handed to him.

A SHAREHOLDER inquired what amount of voting was required to authorise the directors to call up the £8 a share.

The CHAIRMAN stated that the directors could of their own motion have agreed to the proposition now before the shareholders, only they preferred to have the benefit of the opinions and views of the shareholders.

A SHAREHOLDER inquired what the Company would pay for acquiring the patents referred to.

The CHAIRMAN stated that nothing had been determined as to that matter. A proposal was made to them last autumn as to purchasing these patents, and the figures were then stated. They were very large, but he believed he was fully authorised to say that the price would now be considerably less. He did not know what the amount was.

Mr. BREMNER said it appeared to him that the shareholders wished to know whether it was to their advantake to hold the shares and pay the calls, or to exchange them. If a gentleman had 100 shares, and had taken them at par, he had paid £200 in respect of them. It was now proposed to give for those shares others worth £500. By that a profit of £300 was made. If, however, the gentleman kept his shares he was liable for £800 more. If the thing came to grief he would lose £1,000 by holding his shares and paying the calls; while, if he exchanged them, as was proposed, he could not lose more than he had paid for them, which was £200. Therefore, he could not understand there being any hesitation as to the course to pursue. The directors had power to make the calls, and the shareholders were liable to pay them; whereas by effecting the exchange they would receive fully paid-up shares, and, therefore, could not be called on for another farthing.

A SHAREHOLDER pointed out that that view only dealt with the question of liability, but not with the question as to the advantage of retaining or exchanging the shares.

The CHAIRMAN desired to correct a misapprehension as to what one shareholder had said. It had been asked what the Faure Company would pay for the patents, but the Faure Company would not buy them. Another company would be constituted to purchase the French patents, and the question was, should they take an interest in that company? They would do so supposing the new company became possessed of the Faure patents, but the Faure Company would not go into the market and buy the patents.

A SHAREHOLDER inquired whether the Société la Force et la Lumière were the proprietors of any of the patents which it was proposed to purchase. If they were not he thought their offer was thoroughly genuine, but if they were he thought the shareholders should be furnished with further details.

A SHAREHOLDER inquired if the directors had full confidence in the *bonâ fides* of the proposal.

Mr. MORRIS stated that he held 500 shares. When the offer was first put before him he could see no objection to it. On the 1st of January next the shareholders would be in precisely the same position they were now in, if the fully paid shares offered in exchange for their shares were not given to them. In his own case, if the scheme were accepted and acted on he would have shares of the value of £2,000 instead of £1,000, and no liability of £8 a share. If the thing was good they would get one fully paid up £10 share for every two shares they now held, on each of which they had paid £2; whereas if the thing was not good they would be on the 1st January in the same position as they were in now.

The CHAIRMAN stated that these views were his own exactly.

A SHAREHOLDER thought they could not do better than accept the proposal. He believed that the Société la Force et la Lumière was a thoroughly sound and responsible company, with special means to enable them to do all they promised.

The CHAIRMAN hoped it would be thoroughly understood that the offer was not made by the directors, but by the Société la Force et la Lumière, and all that the shareholders had to do if they accepted the proposal was to see on the 1st January, when they gave up their shares to the Société la Force et la Lumière, that they got the equivalent for them. As to the *bonâ fides* of the offer, he was going to exchange his shares, and he was satisfied that he would get fully paid shares in exchange for them. If not he should not part with his shares.

Sir CHARLES CLIFFORD observed that it appeared to him that the *bonâ fides* of the Société la Force et la Lumière were thoroughly proved by the offer itself. No set of mercantile men could by any possibility be so foolish as to put forward such a scheme without having strong backers and a large sum of money behind them.

Mr. STAPLES thought the shareholders were very desirous of knowing why such a liberal offer was made. It seemed to him that M. Philippart and his friends had such a high opinion of the value of the patents that they desired to increase their holding in the Faure Company, and by the process enunciated they were able to get 5,000 more shares at £6 instead of going into the market and paying whatever they were quoted at and could be got for. The Société la Force et la Lumière were willing to pay the sum mentioned, and then they would, he said, make a profit of something like £20,000. He could not help regarding the proposal as a good one both for the shareholders and for M. Philippart and his friends.

The CHAIRMAN, in reply to other questions, stated that the Faure Company would remain as they were. They were only asked whether they would take an interest in the foreign patents, for the purchase of which the money of the calls would be devoted. The Société la Force et la Lumière and its friends hold 31,000 of the shares in the Faure Company, and beyond that number there were only 9,000 shares.

A SHAREHOLDER asked if there would be any increase in the capital of the Société la Force et la Lumière.

The CHAIRMAN replied that he had nothing to do with that Company.

Mr. STAPLES pointed out that no resolution could compel the share holders to accept the offer of the Société la Force et la Lumière.

The CHAIRMAN stated that that was so.

Mr. BREMNER moved, and Mr. R. C. TUCKER seconded, the following resolution:—"This meeting is of opinion that it is expedient for this Company to take an interest, by purchase or otherwise, in foreign patents and inventions in foreign countries, especially in France, for accumulators and all other modes of electricity for lighting, motive power, &c., and especially in the patents granted to Faure, Sellon, and Volckmar; and for that purpose, if found expedient by the directors, to assist in the formation of a company or companies in England or abroad, for the purchase, working, and carrying out of the said patents and inventions, and also, if thought expedient by the directors, to subscribe for shares or take a pecuniary or other interest in the proposed company or companies, to such an amount and on such terms and conditions as the directors of the Faure Company may from time to time think advisable."

The CHAIRMAN, in answer to a question, stated that the shares in the Faure Company held by M. Philippart were not taken by him originally, but had been purchased since. Immediately after the first meeting of the Company M. Philippart and his friends acquired a very large number of the shares. He then put the motion, and declared it carried unanimously. Continuing, he referred to the following resolution, set out in the notice convening the meeting:—"That, on every question to be decided by a poll, every member present, in person or by proxy, shall have one vote for every ordinary share up to ten inclusive, and he shall have an additional vote for every five shares beyond the first ten ordinary shares up to 100 inclusive, and an additional vote for every ten ordinary shares beyond the first 100

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shares. And the holder of every ten deferred shares shall have the same number of votes in respect thereof as if they were one ordinary share, every ten deferred shares being, for the purposes of voting, always equivalent to one ordinary share. No member shall have more than 500 votes in all, and no member shall be entitled to vote on a poll as the holder of any shares in respect of which he shall not have been registered for three calendar months previous to the meeting." He stated that at present, by Clause 64 of the Articles of Association, if any one held nine-tenths of the shares in the Company he would only have 50 votes. He was of opinion that no one should have such an enormous number of votes as to destroy or do what he liked with a company, but between that and fifty votes it was easy to draw a just mean, and it was proposed now that under no circumstances should any one have more than 500 votes, and to that extent the resolution would alter Clause 64 of the Articles of Association of the Company. That seemed to him a fair and equitable arrangement, and he should vote for it.

A SHAREHOLDER thought that in the face of the holding of three-fourths of the shares the effect of the alteration would be to place all power in the hands of the gentlemen who held them.

The CHAIRMAN stated that such a power as that indicated by the last speaker could be exercised now, simply by the dissemination of the 30,000 shares held. He thought the proposal was a fair one. He moved the adoption of the resolution.

Sir CHARLES CLIFFORD seconded the motion, which

The CHAIRMAN put to the meeting, and declared carried unanimously. He added that should they now think the worse of the second resolution passed there was a *locus penitentiæ* for them, as they must have another meeting to ratify that special resolution.

Mr. PINCOFFS moved a vote of thanks to the chairman, whose zeal and ability on behalf of the Company's interests he warmly referred to. The chairman from the first had entertained a very high opinion of the value of the Faure patents, and he (the speaker) believed that his opinions had been strengthened. He hoped that the chairman's most sanguine expectations would be realised.

Mr. G. SMITH seconded the resolution, and it was carried unanimously.

The CHAIRMAN, in reply, expressed his acknowledgements. He had never despaired of the success of the Company, and he only hoped that they would attain it. He must say of M. Philippart that that gentleman had displayed a knowledge of the business which he (the chairman) had not found equalled by any one else.

The meeting then separated.

THE ORIENTAL TELEPHONE COMPANY (LIMITED).

An extraordinary general meeting of the members of the above Company will be held at the City Terminus Hotel, Cannon-street, London, on Monday, the 13th day of November, 1882, at twelve o'clock at noon, for the purpose of considering and, if thought advisable, passing the following resolutions, namely :—

"1. That this Company hereby approve, ratify, and confirm an agreement dated the 8th of August, 1882, and made between Clement Davidson Leggatt, as the agent of this Company in India, of the one part, and John Grey Russell, as the trustee for and on behalf of a Company then about to be formed and incorporated under the name of 'The Bombay Telephone Company (Limited),' of the other part, whereby it has been agreed, subject to confirmation by this Company, to sell the business, goodwill, plant, and property of this Company in the Bombay Presidency, Scinde, and Hyderabad, Deccan, to the said 'Bombay Telephone Company (Limited);' and do hereby authorise and require the directors of this Company to carry such agreement into effect, either with or without any modification, or new terms which they may agree to on behalf of this Company.

"2. That the clause or sub-section marked (*c*) contained in the 60th of the Company's Articles of Association be repealed, and that, in lieu thereof, the following shall henceforth stand and be the clause or sub-section marked (*c*) contained in the said 60th Article ; that is to say :—'(*c*) They may of their own authority sell all, or any part, of the business, goodwill, patents or patent rights, and property of the Company, or the business, goodwill, patents or patent rights, and property appropriated for, or appertaining to, any branch of the Company's business, either wholly or partially, for cash or for shares, debentures, or other interests in any company or corporation, or to any person or persons ; and if deemed expedient, the Directors may hold or (so that the capital of the Company be not thereby reduced) distribute in specie among the members in proportion to their holdings, or otherwise deal with such shares, debentures, or other interests.' "

Should the above resolution, numbered 2, be passed by the required majority, it will be submitted for confirmation as a special resolution to a second extraordinary general meeting of the Company which will be subsequently convened.

LEAKY TELEGRAPH SERVICE.—"The story of a telegram is just now," says the *Operator*, "exciting much comment in Belvidere, N.J. A delegate to the Republican Convention, held at Somersville, October 6, sent an important despatch to a prominent Republican in Belvidere, and after several hours' delay an ambiguous answer was returned. On investigation it turned out that the message, although properly directed, did not reach the gentleman to whom it was addressed, but was received and answered by Mr. Harris, the Democratic candidate. People are inquiring how the message came to be delivered to Mr. Harris, and why and by whom was the original address altered. Unfortunately, says a despatch from Belvidere in reference to the matter, the wires in this section of the State have been considered leaky. The people hereabouts are unanimously of the opinion that this is a proper occasion for some one to rise and explain." These things are managed better abroad—according to some people's ideas.

PURE CARBONS.—Jacquelain (*Compt. Rendus*) describes a process of purifying gas-retort carbon by treatment with chlorine and fused caustic soda, or with hydrochloric acid. He finds that a natural graphitoid carbon from Siberia acquires by purification a luminous power double that which it possesses in its natural state, and one-sixth greater than that of pure artificial carbons.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES Nov. 8.		BUSINESS DONE WEEK ENDING NOV. 8. Highest.	Lowest.
Anglo-American	49,	50	50	49½
Do. Preferred	80,	81	81	80¾
Do. Deferred	19,	20	19¼	19¼
Brazil Submarine	12,	12½	12½	12¼
Cuba	9½,	10	9⅞	9 11-16
Do. Preference	16,	17	—	—
Direct Spanish	6,	6⅜	6¼	6 1-16
Do. Preference	15½,	16½	15¾	15½
Direct United States Cable	11¾,	12	12	11¾
Eastern Telegraph	10½,	10¾	10¾	10½
Do. 6 per Cent. Preference	12¾,	13¼	13¼	13
Do. 5 per Cent. Debentures, 1899	103,	106	—	—
Eastern Extension	11½,	11¾	11¾	11 11-16
German Union	9¾,	10½	—	—
Globe Telegraph and Trust Company.	6⅝,	6⅞	6⅜	6½
Do. Preference	12½,	12¾	12 13-16	12⅝
Great Northern	12½,	12¾	12 11-16	12½
Indo-European	30½,	31½	—	—
Mediterranean Extension	1¾,	2¼	—	—
Do. Preference	8,	9	8¼	8¼
Reuter's	12½,	13	—	—
Submarine	245,	255	—	—
West India and Panama	1⅜,	1⅝	1 7-16	1 7-16
Do. 1st Preference	7,	7½	7⅜	7⅛
Western Brazilian	7½,	7¾	7⅜	7 1-16
West. Union 7 per Cent. 1st Mortgage	121,	124	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

COMPANIES.	CLOSING PRICES Nov. 8.		Highest.	Lowest.
Consol. Telephone and Maintenance	1,	1¼	1 3-16	1 3-16
Oriental	¾,	1	⅞	¾
United Telephone	10¼,	10½	10⅜	10½

ELECTRIC LIGHT.

COMPANIES.	CLOSING PRICES Nov. 8.		Highest.	Lowest.
Anglo-American Brush	9½,	10	10½	8⅞
Maxim-Weston	¼,	¾	⅝	⅛
Eastern Electric	2,	2½	2½	2

TRAFFIC RECEIPTS FOR OCTOBER, 1882.

COMPANIES.	Oct., 1882.	Oct., 1881.	Incrse.	Decrse
Anglo-American Telegraph Company	—	—	—	—
Brazilian Submarine Company	—	—	—	—
Cuba Submarine Company	2,000	2,192	—	132
Direct Spanish Telegraph Company	—	—	—	—
Direct United States Cable Company	—	—	—	—
Eastern Extension Telegraph Company	—	—	—	—
Eastern Telegraph Company	58,173	48,872	9,301	—
Great Northern Telegraph Company	—	—	—	—
Submarine Telegraph Company	—	—	—	—
West Coast of America Telegraph Company	—	—	—	—
Western and Brazilian Telegraph Company	—	—	—	—

DANGER FROM OVERHEAD ELECTRIC-LIGHT WIRE.—*Apropos* of the recent death of a workman through the current from the wire of a Brush arc lamp, Mr. Edison is said to have confided to the reporter of a New York paper his opinion that such accidents would continue to increase with the multiplication of wires carrying powerful currents, till some dreadful accident occurred to arouse public indignation and compel the placing of all such wires underground. In case of fire particularly, the breaking of a great number of wires, which would be thrown down in inextricable confusion, by the fall of a roof, might have serious results. Mr. Park Benjamin, a well known scientific man, has called attention in New York, to the fact that a stream of water from a hosenozzle, striking a broken arc-light wire, might easily serve to conduct the current through the body of the fireman who held the hose, with fatal consequences, while the cutting of such a wire with an axe, particularly if the handle of the axe were wet, might have a like effect.—*The Times*.

HEAT DEVELOPED BY MAGNETISATION.—M. Gilleux has recently described that he found on passing the alternate currents from a De Meritens machine through an electro-magnet the iron core of the electro-magnet heated to the extent of 200deg. Cores made of non-magnetic metals were not so heated, and the heating of iron and steel cores increased with their coercive force, which appears to play a similar part in magnetisation as electrical resistance does in a conducting wire.

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